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Editorial—

The Truman Doctrine and the Bomb . . .

The division of the world into two zones of influence seems to have originated in Teheran, and all available evidence indicates that it was not of American making. But we consented to become partners to this division, and have exchanged the vision of a world community under the law for the more familiar pattern of balance of power.

In this division, vast areas inevitably remained front zones or no man's lands, destined to become objects of strife. Yesterday it was Iran, today it is Greece, tomorrow it may be Korea or Afghanistan. The fear of destruction in a future atomic war drives each side to push its defense perimeters and its attack bases as far forward as possible. Unless the world can be neatly and unambiguously divided between two empires—which is not likely—one conflict after another will be inevitable, and each will threaten to erupt in war.

If it were not for atomic power, America could face this contest of empires with the confidence that by maintaining her dominant position on the seas and in the air she could make certain that any future conflict will be decided far from her shores and thus not endanger our survival as a free and powerful nation. But in a war fought with atomic weapons, America will face crippling blows—perhaps even more crippling than the ones she may be able to inflict on an economically less vulnerable enemy. Therefore, the foremost task of our policy must be to prevent the state of affairs in which several nations will be armed with atomic weapons.

Keep the Secret!

A loud chorus of "realists" urges America to "keep the secret". Keep the atomic bomb an American monopoly! Oh, if we only could! There is obviously no sense in disclosing gratuitously the American production secrets. All misrepresentations to the contrary, no reputable American scientist, and no organization of atomic scientists have ever advocated such a "gesture". Why should we do anything to *accelerate* the Soviet advance towards atomic armaments? But unfortunately, we cannot *delay* it. Those who have the best knowledge of our nuclear technology, and the best appreciation of Russian science and engineering, give from 3 to 15 years as the time the Soviet Union will need to acquire its own atomic bombs. Even the longest suggested term is much too short to give us any comfort. Those who preach that we have only to tighten the secrecy around our atomic laboratories and plants to make us safe are the worst deceivers of the American people and traitors to American Security.

The Truman Doctrine

The new American policy, inaugurated in Greece and Turkey seems to be to accept openly the challenge of the "two worlds" and to oppose vigorously any attempt to shift the present demarcation line between them. This policy has been criticized as leading to war. But if the alternative is to retreat and concede one area after another, then the experience of 1938-1939 shows clearly what policy is least likely to ensure "peace in our time". But containing successfully the Soviet domination within its present bounds will not solve the central problem of our security—that of atomic weapons. True, we may thus prevent Western Europe from becoming an adjunct to the Soviet scientific and technological arsenal. We may keep most of the U.S.S.R. under the threat of our advanced bases for the delivery of atomic bombs, and prevent the Soviet bases from being pushed that much closer to our shores. But these are but relative and temporary advantages. The Soviet Union will acquire bombs even without the help of European slave scientists and engineers; and as soon as this happens, the nations in which our advance bases are situated, will become open to destruction even with the present-day rocket and planes as the only means of delivery. America may thus be able to keep these advanced bases only at the cost of exposing friendly nations to total devastation, and thus, probably, only against their will.

Agreement Imperative

The blunt truth is that the Soviet Union can be prevented from acquiring atomic arms only in two ways: by effective agreement, or by force, directed not towards her periphery, but at her very center. One may think of this force in terms of

(Continued on Page 136)

In This Issue

Calling for a Crusade.....102
by Leo Szilard
The President Addresses the World.....107
by Abba P. Lerner
The International Control of Safe Atomic Energy.....111
by Cuthbert Daniel and Arthur M. Squires
Economic Aspects of Atomic Energy as a Source of Power....117
by Sam H. Schurr
Atomic Energy in the News.....121
The Organization for Science in the Federal Government.....122
by Philip N. Powers
Legislation for a National Science Foundation.....124
A Bibliography of Atomic Energy..127
by Morris C. Leikind

Calling for a Crusade. . . . . by Leo Szilard

(The following article is printed prior to publication with the permission of the Saturday Review of Literature.)

AS far as I can see, I am not particularly qualified to speak about the problem of peace. I am a scientist and science, which has created the bomb and confronted the world with a problem, has no solution to offer to this problem. Yet a scientist may perhaps be permitted to speak on the problem of peace, not because he knows more about it than other people do, but rather because no one seems to know very much about it.

Some of us physicists tend to take a rather gloomy view of the present world situation. We know that Nagasaki-type bombs could be produced in large quantities, and we know that the United States would be in a very dangerous position if large stockpiles of such bombs were available to an enemy at the outbreak of the war. Moreover, when we think of a war that may come perhaps ten or fifteen years from now, we do not think of it in terms of Nagasaki bombs. Nagasaki bombs destroy cities by the blast which they cause. But ten or fifteen years from now giant bombs which disperse radioactive substances in the air may be set off far away from our cities. If such giant bombs were used against us, the buildings of our cities would remain undamaged, but the people inside of the cities would not remain alive.

The traditional aim of foreign policy is to prolong the peace, i.e., to lengthen the interval between two wars. We physicists find it difficult to get enthusiastic about such an objective. The outlines of a war which may be fought with these weapons of the future are now becoming more and more clearly visible from our vantage point, and if we accepted the view that the world has to go through another war before it arrives at a state of permanent peace, we would probably pray for an early rather than a late war. Clearly, foreign policies which may prolong the peace cannot furnish the solution to our problem.

Collective security might very well have solved the problem which faced the world in 1919. Assuming American participation, perhaps it could have been made to work under conditions different from those which prevail today. But the ills of 1947 cannot be cured with the remedies of 1919. With the United States and Russia far outranking in military power all other nations, there is no combination of nations which could restrain by force either of these two giants.

No balance of power in the original meaning of the term is possible in such a situation, and there has arisen between the Russian government and the government of the United States, a rather peculiar relationship. Because of the possibility that they might be at war with each other at some future time, these two governments consider it their duty to put their nations into the position of winning that war if war should come. Stated in these terms, the problem is not capable of a solution which is satisfactory to both parties and Russia and the United States are thus caught in a vicious circle of never-ending difficulties.

This peculiar relationship between them became apparent sometime between Yalta and Potsdam. Just what caused the change in their relationship is difficult to say. Perhaps there was no particular cause other than the fact that these two countries lost their common enemy before they reached an agreement on a post-war settlement.

Russia's desire to push her frontiers in northern Europe as far West as possible can be understood on the basis of strategic considerations. We observe further that she takes active steps for the purpose of dominating politically a number of Balkan countries which are strategically important to her such as, for instance, Rumania. The United States takes active steps for the purpose of keeping friendly governments in Greece and Turkey. Obviously, friendly governments in these countries would secure access to the Black Sea for the American and British fleets and would, in case of war, enable us to carry the war to Russian ports there. Friendly governments in Greece and Turkey are desired by us also in order to be in a better position to defend the Mediterranean including the oil deposits in the Middle East upon which we would want to draw in case of war.

Any economic aid that Russia may get would in some measure increase her ability to fight a war, and we note that when Russia was on the point of obtaining a loan of several hundred million dollars from the Swedish government, the United States ambassador protested against the granting of such a loan. The only economic aid which Russia was able to secure with our approval was a total of 250 million dollars of relief granted by UNRRA. This aid went to the Ukraine and Byelorussia and it is less than the amount of relief which Italy was able to obtain.

All this does not mean, of course, that either the United States or Russia want war. It merely means that they want to win the war if there is one. But as long as Russia and the United States will allow their policies to be guided mainly by such considerations, their course will be rigidly determined, and they will retain little freedom of action for working toward the establishment of peace.

Negotiations on Control of Atomic Energy

How does atomic energy and the bomb fit into this picture? Atomic bombs may be the only effective weapon by means of which Russia could carry the war to the territory of the United States if there should be a war. Clearly, this is good and sufficient reason for the United States to try to eliminate atomic bombs from all national armaments. But can we see clearly for what specific reason Russia should be expected to concur, particularly if the methods of control involve measures which are difficult for her to accept?

In order to have effective control of atomic energy all over the world, the

LEO SZILARD is Professor in the Institute of Radiobiology and Biophysics and in the Division of the Social Sciences, at the University of Chicago. He is well-known as a pioneer in the field of atomic energy.

United States proposes to set up an Atomic Development Authority in charge of the mining, refining and manufacturing of uranium and other dangerous materials. It is a good proposal and it is difficult to see how control could be made effective on lesser terms. But, keeping in mind the possibility of war, it is easy enough to understand why Russia hesitates to agree to such a proposal. Large scale operations of such an agency on Russian territory would give the United States and other nations access to information of strategic importance to which they have no access at present, such as the details of the road and the railroad systems and the location of various industries.

What are the reasons which might, nevertheless, move Russia to agree to some effective method of control on the basis of the present negotiations? Such an agreement would greatly reduce the mounting tension in the world and improve our chances of avoiding war. In this sense at least it would serve the interests of Russia as well as the interests of the United States. Moreover, as long as the United States has a stockpile of atomic bombs and Russia has none, Russia cannot be certain that she will not be attacked and that the United States will not wage a preventive war, perhaps on the very issue of the control of atomic energy. Today it is difficult for us to imagine that this country would ever take such action. Having ratified the United Nations charter, we can not legally go to war except in the case of an armed attack or on the basis of a unanimous vote in the Security Council of which Russia is a member. The mere refusal of Russia to enter into an agreement on the control of atomic energy could hardly be construed as an armed attack. From the legal point-of-view, Russia would be within her rights if she built up a stockpile of atomic bombs and planes and rockets suitable for their delivery. She would only be doing what we are doing ourselves.

As matters stand at the moment, Russia has no atomic bombs. Feeling in this respect secure, we find it easy to see all this very clearly and, therefore, we recognize that such a preventive war against Russia could not be justified from a moral point-of-view. But can we predict how we shall react if the day approaches on which Russia has a stockpile of bombs and airplanes and rockets suitable for delivery at a moment's notice? Can we visualize what kind of a life we shall be leading when we shall have to fear for our lives and the lives of our children, when the city in which we live, as well as all the other cities in the United States, shall appear to be in danger of being burned and smashed without warning? I do not venture to predict how we would react in such a situation, but I would not vouch for anyone I know, not for any of my friends nor even myself—in such a situation; I would not vouch for anyone's giving moral considerations the weight which we give them at present and which they deserve. The most ardent advocates of international cooperation might then turn into the most ardent advocates of a preventive war.

As long as we have bombs and Russia has none, she cannot be certain that we are not going to attack her. This is just the situation in which Russia finds herself today. At present we propose to eliminate atomic bombs from all national armaments by setting up an international control agency, and we offer to the Russians, as the main inducement, to discard our own bombs at an early date and thus to free Russia from the danger of being attacked.

Perhaps we will succeed in reaching an agreement on this basis and perhaps we won't, but it is a very narrow basis on which to negotiate. Russia and the United States are caught in a vicious circle at present, and it is not likely that this circle can be broken by negotiating on the issue of atomic energy as if it were an isolated issue.

Is it possible to break out of this vicious circle in which we are caught? And is it possible to go further and to reach the state of permanent peace without going through another world war?

Most of us physicists believe that nothing short of a miracle will bring about such a peaceful solution. But a miracle was once defined by Enrico Fermi as an event which has a probability of less than ten per cent. This is just Fermi's way of saying that there is a general tendency to underestimate the probability of unlikely events. And if we have one chance in ten of finding the right road and moving along it fast enough to escape the approaching catastrophe, then I say let us focus our attention on this narrow margin of hope, for another choice we do not have.

It is easy to agree that permanent peace cannot be established without a world government. But agreement on this point does not indicate along what path that ultimate goal can be approached, and not only approached but also reached in time to escape another world war.

Since our desire for security is the main reason for wishing to set up a world government, it may seem logical to propose that we set up at once a limited world government, which would deal only with the problem of security and the settlement of conflicts between nations, but would have practically unlimited authority within that narrow scope. Logical though this may seem, I wonder whether such a frontal attack on the problem of security is a promising approach; I am inclined to doubt that it is possible to achieve security by pursuing security.

Control of Atomic Energy

On the basis of the present negotiations we might at best arrive at an agreement providing for general disarmament and for the control of atomic energy along the lines of the Acheson Report. This would mean that we set up an Atomic Development Authority which is in charge of the mining and manufacturing of fissionable materials all over the world. But if this Authority lives up to its obligations to promote the peacetime uses of atomic energy, ten or fifteen years from now a number of atomic energy power plants will be in operation in various parts of the world—many of them on the territory of Russia.

What should be the distribution of these power plants between the various nations? Should they be distributed according to economic needs? Or should they be distributed on the basis of military considerations? Is it possible to safeguard plants which are located on the territory of one of the major nations against seizure by the government of that nation? And if this cannot be done effectively, ought the United States to exert her influence to

keep the absolute number of these plants as low as possible while their distribution may be fixed by some sort of a quota agreement?

I believe the longer one thinks about the problems which would arise from such a situation, the more difficulties one will discover. As long as considerations of relative military strength remain the predominant considerations it will not be possible to resolve these difficulties.

Clearly, as far as the United States and Russia are concerned, any agreement in this field will have to be regarded more as a voluntary arrangement than an enforceable obligation. Perhaps there will be an armed force under the United Nations in the foreseeable future which could compel the observance of obligations of this sort by most of the smaller nations, but in the absence of atomic bombs such an armed force will certainly not be strong enough to coerce the United States, nor is it likely to be strong enough to coerce Russia.

Under such circumstances the question of incentives becomes the predominant question. The United States has obviously strong incentives for maintaining an arrangement that will eliminate atomic bombs from all national armaments. Therefore the question of what incentives Russia will have for wishing to keep such an arrangement in force and what incentives she will have for wishing to abrogate it becomes the controlling factor. The problem is to find conditions under which the incentives will be overwhelmingly in favor of continued cooperation rather than abrogation.

It seems to me that this requirement could be satisfied only within the framework of an organized world community. Only within such a framework could we hope to maintain arrangements between nations long enough to give the world a chance to work out the ultimate solution of the problem of peace. Perhaps if the United States were to take the lead and if she were willing to mobilize her great material resources for this purpose, such a world community might become a reality fast enough to enable us to pass without a major accident through the transition period.

Organized World Community

A world community of this sort would require the setting up of a number of world agencies and perhaps also some special agency to coordinate their activities. What should be the function of these agencies? What should be their scope and scale of operation?

Groping in the dark I have made an attempt to outline the functions of at least a few such agencies. These and other agencies taken together might form the skeleton of a structure which may be capable of transforming itself within one or two generations into a genuine world government. In the meantime, each of these agencies would have its functions clearly defined by its charter, and all of these charters taken together would represent the world laws as soon as they are ratified by the United States, England, and Russia, as well as a certain number of other nations. The more clearly the operation of these agencies is defined by their charter, the less need there will be for more or less arbitrary political decisions later. Countries which have political systems as different as the United States, England, and Russia, cannot be expected to delegate in the foreseeable future vast law-making powers to any international body; it is easier for them to agree on what the laws should be than to agree on how the laws should be made.

The agencies which I have contemplated would operate on a budget of about twenty billion dollars per year.

They might move, in the next twenty years, in amounts of two to four billion dollars per year, farm products from the United States to densely populated industrial countries which are unsuitable for agriculture such as, for instance, England, Germany, and Belgium.

They might undertake the building up of a vast consumers' goods industry in a number of countries including Russia.

They might lessen the economic insecurity of nations exposed to the repercussions of booms and depressions that hit the United States. They might do this by purchasing large quantities of raw materials from these nations when importation of these materials into this country is at a low ebb, i.e., during depressions and by selling these materials from stock to importers in the United States during booms.

They might tend to stabilize economic conditions in the United States by keeping the export of the United States at a high level during depressions and at somewhat lower levels during boom periods.

They might provide for the supervision of general disarmament and for the effective control of atomic energy installations all over the world.

They might provide for redistribution of strategic raw materials and other scarce raw materials which might otherwise be monopolized by certain nations, but they need not go quite as far in this respect as in the case of uranium and thorium.

They might enforce peace by maintaining an armed force strong enough to be able to restrain from illegal action most of the nations but not strong enough to coerce the United States or Russia.

Changing the Pattern of Loyalties

All these functions so far mentioned relate to the redistribution of goods and services, and to security, but there is need for agencies which would serve a different purpose. The value of such agencies ought to be judged by asking how they would affect our lives, and by affecting our lives, affect our loyalties. For unless we can bring about a rapid shift in our present pattern of loyalties, a stable world community will not become a reality fast enough.

In America a man born in the state of New York may go to study at Harvard in Massachusetts and may, if he chooses to do so, settle in California. Few men born in New York State will actually do this, but the fact that all of them are free to do so, if they so desire, makes them look upon other states as potential places of study and potential places of residence, rather than potential battlefields. Can we bring about a similar situation in the world without opening the door to large-scale migration and can we by doing so materially change the present pattern of loyalties?

Many of the men who influence public opinion by speaking or writing come from a small class of people—the class of people who have had the advantages of higher

education. Their attitudes and their loyalties will in the long run, affect the set of values accepted throughout the whole community.

An agency in charge of student migration might be given the right to place, say, up to twenty per cent of "foreign" students into the colleges of any one country and could pay for their tuition and living expenses. Moreover, twenty per cent of the "foreign" students who graduate in any one country might be given the right to settle in that country, if they choose to do so.

In the United States we have at present an inflated student body of about two million college students. According to this scheme about four hundred thousand might be "foreigners." Since students spend an average of four years in college this means that every year one hundred thousand "foreign" students would enter the United States and out of these every year about twenty thousand might decide to stay permanently in this country. This is well within the limits set by the immigration laws, but new legislation would be required in some other countries before they can participate on equal terms.

If such a scheme were in operation, the total number of persons involved in this migration would be small, but every high school student, all over the world would look upon the United States and other major countries as potential places of study. Only a small fraction of the "foreign" students graduating in the United States might finally decide to stay here for good; most of them would not make up their minds about this until they actually graduate and see what positions are open to them. But in the meantime all those who study here in the United States would look upon this country as their home—at least potentially.

Assuming that every one of these "foreign" students received in the United States an allowance of $2000 per year all of them together would cost less than one billion dollars per year, and this amount would come out of the general contributions of the United States towards the budget of the world agencies. Similarly American students in England and Russia would receive yearly allowances paid out of the English and the Russian contributions. Many American students might be induced to study under this scheme abroad where they can study free rather than at home where no one takes care of their living expenses and tuition.

Access to Information

Another agency might be delegated the task of giving access to "information" to everyone everywhere in the world. This agency might be given jurisdiction over one page of every newspaper in the world. The agency could either function as the "editor" of that page or it could suitably assign the pages under its jurisdiction to other newspapers. Thus for instance, a page in the Chicago Tribune might be assigned to the London Times, and a page in the London Times to the Chicago Tribune. A page in the New York Times might be assigned to Pravda, and a page in Pravda to the New York Times. It is difficult to forecast at the present time who would oppose such a scheme more vigorously, the "publisher" of Pravda or the publisher of the New York Times.

Some of these agencies would be more acceptable to the Russians than others, but a world community cannot be built by reaching agreements piecemeal and the whole pattern of agencies, properly balanced, will have to form a single package, which provides for at least the first steps towards a universal bill of rights. Just when and in what circumstances such a package might be acceptable to Russia is a crucial question which requires careful consideration. Something more will be said about this later.

Recognition of Limitations

The obstacles to plans of this sort are obviously great but such plans can be kept within the realms of practical possibilities if we clearly recognize the limitations which we have to accept for the present.

We cannot give to such agencies the responsibility of maintaining full employment throughout the world because the United States is internally split on the methods which might be acceptable to her for achieving this end.

We must not expect to cope in the next twenty years with raising the standard of living everywhere in the world, for the high birth rate of India and China makes it impossible to attack this problem on a worldwide scale by purely economic methods.

And finally, in view of the present pattern of loyalties it does not seem advisable to delegate to such agencies the right of opening the door for large-scale migration by removing immigration barriers.

The Issue

There are a number of international agencies in existence today. It might be possible to create new agencies and to increase the scale of operation of the old ones. But to me it seems very likely that if progress were attempted on such a piecemeal basis and without having put the problem before the American people, such an attempt would be defeated.

To me it seems that the hope of smuggling 140 million people of this country through the gates of Paradise while most of them happen to look the other way is a futile hope and that only a full understanding of what is being attempted would have some chance of success, small though that chance may be. The problem which faces the world today can be solved only by the initiative of the American people. And it can be solved by them only if they understand their own position in the world and if they give their government a clear mandate to take the leadership for the creation of a world community. The first step in this direction is to put the problem squarely before the American people and to put the emphasis where it belongs.

The American people will soon be faced with a crucial decision. This decision is not so much what amount of national sovereignty we are willing to give up. Undoubtedly more and more sovereignty will have to be given up as time goes on, but the main issue is not the issue of sovereignty. The main issue is whether we are willing to base our national policy on those higher loyalties which exist in the hearts and minds of the individuals who form the population of this country but which do not find as yet expression in our national policy. The main issue is whether we are willing to assume our full share of responsibility in the creation of a world community.

If we are willing to do this we should be willing to mobilize our material resources for this purpose on an adequate scale. We should think of our contribu-

tions for the next twenty years as amounts reaching up to ten per cent of our average national income, i.e., up to about fifteen billion dollars per year. Fifteen billion dollars, if spent for this purpose, would of course, mean a surplus export of approximately the same amount. This could easily double and treble the rate at which industrialization proceeds in the world outside of the United States.

Available Resources

We are quite willing to spend at present about ten per cent of our national income for the Army and Navy. Unless we are very fortunate, we may have to continue to spend in one form or another such sums for defense for the next five or ten years and our contribution towards building up a world community would then be an additional burden on our economy. But even so, once reconversion to peacetime production is completed we could assume such a burden without any reduction in our standard of living, for at this particular juncture we have a unique opportunity. Sixty per cent of our manpower was tied up in war production up to a short while ago. Assuming that we could maintain a high level of employment, we could expect an *enormous* increase in our standard of living. We could take on our share of the burden and still have an *appreciable* increase in our standard of living, and, moreover, a somewhat better chance of actually maintaining a high level of employment.

Obviously, it would be difficult for us to have an export surplus of fifteen billion dollars in boom years, and this should not be expected from us. But our export surplus in boom years could be kept small, say, 7 to 10 billion dollars, and only as we move toward a depression might it have reached the peak of 15 billion dollars.

Methods of Financing

The question of financing the contribution of the United States would be up to our Government. It might, for instance, decide to rely on taxes during the boom and on the issuing of "Peace Bonds" during the depression. In the next twenty years during which this scheme would operate we might have to expect an increase in the public debt, but there is no reason why the total increase during this long period should be larger than the public debt incurred within a few years during the war within a much shorter period.

Equal Obligations

Let us not attempt to maintain the illusion that the rest of the world can repay us at any time in the form of material goods. The productive capacity of this country is enormous. If a high level of employment can be maintained our standard of living will rise rapidly and the working hours will fall rapidly to the point where the problem of disposing of leisure may come into the foreground of public attention. There will be no need and no occasion, unless time should go into reverse, for our asking or receiving repayment in goods.

This does not mean that the countries who may receive help in the next ten, fifteen or twenty years shall receive gifts without assuming obligations. These countries ought to have precisely the same obligation as the United States, i.e., the obligation to contribute to the development of the world up to ten per cent of their national income. Their actual contributions ought to be determined by the objective needs and on the basis of available resources. On this basis, however, most of these countries will probably be free for a number of years from any but rather small contributions. Gradually, more and more of them will be able to take on their share of the burden, and twenty years from now the productive capacity of Russia may very well be drawn upon in the early phases of the industrialization of China and India.

There is little reason for expecting any of the countries who would receive help to display gratitude. Nor is there much reason for looking upon our own contribution as anything but evidence that at last we have made up our minds to do our duty by the world. Raising the standard of living in certain countries or throughout the world in general will not in itself make the world more peaceful. A higher standard of living does not automatically promote or favor higher loyalties. But such higher loyalties will be developed if the world agencies affect the life of the individual, and by affecting his life, affect his loyalties. And above all, the very fact that the people of this country have voluntarily assumed their share of responsibility would be regarded everywhere as a token of our facing not towards war but towards peace.

Within such a framework Russia might receive on the basis of objective needs and available resources perhaps five billion dollars per year. No sane person can believe that we are solely concerned about winning the next war if we are spending a substantial fraction of our national income for the welfare of those countries who would most likely be our enemies in case of war. In such circumstances we might even maintain a considerable military establishment and continue to spend billions of dollars for defense and yet find that other nations consider such action on our part as foolish and extravagant behavior rather than a threat to their security.

All this presupposes, of course, that we are really going to make the building up of a world community the cornerstone of our national policy and that the world can count on the continuity of such a policy. This probably cannot be achieved without amending the Constitution. The Constitution was twice amended in this century over the issue of prohibition, and if we are willing to go out of the way for the sake of being permitted to drink or for the sake of preventing others from drinking, maybe we shall be willing to go out of our way for the sake of remaining alive.

Organized Political Action

The suggestion that this country should commit herself to contributions up to ten per cent of her national income sounds perhaps Utopian. Perhaps it will be asked why not be satisfied with making progress as fast as we can? Why not propose large-scale loans which the United States might make to other nations directly or through the medium of international agencies?

To me it seems that this more modest objective would be neither adequate for the purpose nor would it be very much easier to achieve. Certainly we could make loans to other nations on a large scale and actually receive repayment in

(Continued on Page 125)

The President Addresses the World ... by Abba P. Lerner

[The following article was written soon after Hiroshima and Nagasaki, but the time seemed inauspicious for the publication of so frank a discussion of the possibility of war between the U.S. and Russia. The course of events has increased rather than lessened the timeliness of Mr. Lerner's article. The author has chosen to present his ideas in the form of a presidential proclamation. The Editors]

FELLOW CITIZENS of the United States — fellow members of the Human Race. My responsibility as President of the United States has constrained me until this hour to keep silent on the most important matter that has ever confronted me, or indeed anybody else. But the matter can wait no longer. With the atom bomb so soon to be in the arsenals of many nations the same responsibility now drives me to speak out with complete frankness about the greatest issue before mankind.

The issue is not a new one. The atom bomb did not create it or even change it. This first of human problems has long been ,and is still, whether civilization will put an end to war before war puts an end to civilization. But the atom bomb has hastened the day of judgment. It is now to be decided whether the twentieth century will show the end of the human adventure or whether it will mark the beginning of its glorious fulfillment.

The responsibility for the fateful decision falls more heavily on the United States of America than on any other nation, and it falls more heavily on the President of the U.S. than on any other man. The full recognition of the critical nature of the present moment in the history of the whole world forces me to depart from the customary glosses of diplomacy and to speak today in plain words.

The Real Danger

We are drifting toward a war between the U.S. and Russia and we are moving toward this war with increasing speed. When the imminence of such a catastrophe first becomes apparent it is usually declared to be "unthinkable" just as the last war was declared to be "unthinkable" around 1934. The threatening conflict has passed beyond that stage and everyone is thinking about it.

There is no serious danger of any other source of world conflict. If there were any sign of a Spain or an Argentina or of one of our former enemy countries preparing to qualify as a great power by the acquisition of some atomic bombs, immediate military action by the U.S. or by Russia would clear up the matter in a few hours—unless, indeed, this were merely the incident signaling the beginning of the conflict between the U.S. and Russia. That many people speak as if the danger of world war came from a revived Germany or Japan only shows what nonsense people will talk in order to keep away from the unpleasant "unthinkable" reality.

A similar running away from the issue is shown in the vast exaggerations of the importance of nuclear fission for peaceful purposes and even in the concern lest extravagant military precautions should unduly interfere with the freedom of scientific inquiry. Scientific research is of great importance. The ultimate benefits from the utilization of atomic energy for peaceful purposes may be tremendous. But surely every sane man would be delighted to sacrifice the next ten or even fifty years of scientific progress if there were reason for believing that this would seriously help to prevent the next war so that there will be a world in which science can advance.

Our primary problem is not to defend scientific freedom or scientific progress, and it is not to prevent monopolistic restrictions on the peacetime application of nuclear energy. Our primary problem is to prevent the war between Russia and the U.S.

Deadly Distrust

I do not think that anyone in the U.S. fails to recognize how great was Russia's contribution as our gallant ally in the war against Germany, and Russia recognizes how great was the contribution of the U.S. to the victory. There can be little doubt that if either the U.S. or Russia, or England had not played its part, all the efforts of the other allies would not have sufficed to win the war. But this does not alter the crucial fact that at the present time we do not trust Russia, Russia does not trust us, and we and the Russians are drifting toward the calamity.

I must here stress the obvious truth that the distrust is not made inevitable by the difference in our economic systems. We were able to cooperate during the war although we made effective use of the techniques of private enterprise and the Russians had for many years outlawed it from their economy. We are not directly affected by the Russians' use of collectivist techniques of economic organization and the Russians are not harmed by our extensive use of private enterprise side by side with our public enterprises.

The degree to which any country makes use of private or collective enterprise in its economy is a private matter that need affect other nations no more than its language or its table manners. Collectivist countries can exist side by side with capitalist countries and with mixed economies, and all can gain from exchanging their products with each other in mutually beneficial trade. If there were an inherent incompatibility between collectivist and capitalist economies, our case would be even graver than it is.

Russia's distrust of the capitalist world is based in the first place on her experience of capitalist intervention in the early years of the Bolshevist Revolution. Twenty years of peace and the joint fight against Naziism might have overcome this painful memory, but the Russians are brought up on a doctrine which teaches

ABBA P. LERNER, distinguished economist and author of "The Economics of Control," is Professor of Economics on the Graduate Faculty of Political and Social Science, New School for Social Research, N.Y. He is currently on leave, and teaching at Roosevelt College. He was formerly Lecturer at the London School of Economics.

them that it is impossible for a capitalist society to maintain economic prosperity without engaging in imperialist expansion, aggression, and war.

This means that however well intentioned the present rulers of the capitalistic countries may be, they or their successors will be forced to wage war, perhaps at first against each other, but ultimately against the U.S.S.R. The Russians therefore believe that as long as any strong capitalist countries continue to exist they must be prepared to meet aggression.

American distrust of Russia is largely based on the recognition of this Russian distrust of the capitalist world. Before the atomic bomb the obvious policy for America and the rest of the capitalist world was to prove to the Russians, by actual accomplishment over several decades, that capitalist countries can maintain prosperity through full employment policies without having to go to war. The atom bomb has taken away the time needed for such a long-period demonstration and has given point to a second American suspicion of Russia.

This is the suspicion that comes from supposing the Russians to be dedicated to the final spread of communism over the whole world and ready to support that conquest with Russian arms. Whether this is their purpose or not, I have heard no one deny that the suspicion has been strengthened by recent Russian political action in states bordering on Russian territory. And those who feel this suspicion can dramatize it by pointing at Russia's political dynamism and ruthlessness, undoubtedly greater than that of the capitalist powers, and at the fact that in a few years Russia will have the atomic bomb too.

Parallel to this there is the suspicion felt by many Russians and by their friends in capitalist countries that capitalist nations are led by ideological considerations to plan the destruction of the Union of Socialist Soviet Republics. The most important thing in both cases is not whether the suspicions are justified but that the suspicions are felt by many people. To show, no matter how logically, that these suspicions are groundless is no more useful than to follow the diplomatic custom of pretending that they do not exist. There is not the slightest doubt that the suspicions exist and that they are driving us to destruction.

The Push-button War

If we allow several years to elapse without producing anything more effective than the United Nations, as now developing, we will find ourselves in a completely hopeless situation. Many nations will have atomic V2's and all will be living under the imminent threat of the release of the other nations' V2's. Every nation will feel that its only salvation lies in destroying its enemy first and will try to be ready to push the buttons before the enemy does. Each nation will also have considered the possibility of not reaching for the buttons in time and will have atomic V2's spread in inaccessible places for punishing the enemy if her own cities should have been destroyed first.

When this state of ultimate preparedness has been reached there will be no more hope. Any rumor or accidental explosion or the act of some madman will force every nation to push its buttons. There will be no time for investigation and the destruction of civilization will take, not years or months, but minutes. Even an attempt to save the world at that time may very well start off the final wave of suspicion that leads to the pushing of the button. It is only in the few years of grace *before* we are all prepared that there is any hope.

It has frequently been suggested that we allay Russia's suspicions by "giving her the secret" of the atom bomb. If this means anything at all it means that we should send our atom bomb engineers to Russia to show her how to make the bombs in a few weeks or months instead of in the few years it will take her without this instruction. This can only make the situation worse, because the only result will be to deprive ourselves of the few years we have in which to prevent the ultimate preparedness.

It must be emphasized that this conclusion in no way rests on any assumption of aggressive intentions on the part of Russia. No matter how sincere the Russian desire for peace, it is still true that to speed up Russia's ultimate preparedness is only to hasten the advent of the same fatal situation with everybody's fingers on the deadly buttons.

The only hope that I can see is in some kind of International Police Force to keep the peace. Such an International Police Force would, of course, take over the atomic bomb with all the materials, instruments, and skill for making, using and further developing it. It would also have complete control of all other powerful weapons, such as battleships, bombers, tanks, rockets and so on; the national forces being left with only such weapons as are necessary to deal with burglars and the like.

The International Police Force would, of course, have to inspect all the world to be sure that no power was secretly preparing atomic bombs or other weapons which could threaten the rule of international law. Without thorough inspection the whole business would be a farce. Full and free inspection all over the world by the agents of the International Police Force to prevent secret armament would be an essential condition for its success.

Those who have expressed skepticism over the possibility of effective inspection for atomic armament all over our planet have usually assumed that only atomic bombs were to be subject to inspection—that nations would still be permitted to have military secrets in connection with other armaments and that private industrial secrets would continue to be hidden from the eyes of the inspectors.

On these assumptions the skeptics are probably right. But the only sensible conclusion is that the assumptions must not be permitted to stand. All other heavy armaments must be handed to the International Police Force together with the atomic bomb, while secrecy in industry must also be sacrificed, with proper compensation for those who would bear more than their fair share of the burden, wherever such secrecy would impede adequate inspection. This may be considered a high price by some (while others might even welcome it) but who can say that it is too high a price to pay for survival?

Three Fundamental Freedoms

Merely hiring inspectors is not enough. There are three freedoms which are fundamental for world peace. These freedoms are very desirable on their own account, but this is not why I bring them

up in the present connection. It is vital not to jeopardize peace by insisting on anything, no matter how desirable, which is not absolutely essential for peace. Many conditions, whose universal establishment is greatly to be desired, must be ignored here. I list the three fundamental freedoms not because of their direct contribution to the dignity of man but because without them peace cannot be secured. Any effective plan for world peace must inisist on them with absolute inflexibility.

The first fundamental freedom is *Freedom of Speech.* This includes the various specific prerequisites for making it effective, like freedom of the press, freedom to listen to the radio and see the press of other countries, freedom of travel for newspaper reporters and the like. Without such Freedom of Speech, it would be possible for a national government effectively to sabotage the inspectors.

The second fundamental freedom is *Freedom of Movement.* People must be free to move in and out of all countries, together with their families, or others who might be held as hostages to prevent them from saying abroad what they may be afraid to say in their own countries. Freedom of movement is a necessary condition for real freedom of speech. In its absence authoritarian governments can give their populations quite false notions of what the outside world is like and in this way prepare them to support movements dangerous to world peace. It is to be hoped, of course, that there is no basis for such suspicions, but even if they were completely groundless, the removal of the restrictions on movements are essential for the elimination of the suspicions and the elimination of the suspicions is essential for world peace.

Freedom of movement does not necessarily involve unlimited freedom of *immigration.* But restrictions on *emigration* must be removed if there is to be any confidence that there is freedom of speech.

The third fundamental freedom is *Freedom from Discrimination,* on a basis of Race, Creed, Caste, or other non-functional distinctions. This freedom is not absolutely necessary for peace in the immediate future because in most cases oppressed religious and racial minorities are not strong enough to wage war. But racial discrimination is going to become more and more dangerous for peace in the future and no permanent stability can be built unless the resentments of myriads of oppressed racial groups are eliminated.

Everything else can be left to each country to arrange according to its preferences. But the fundamental freedoms and the right of unlimited investigation by its inspectors, together with its monopoly of heavy armaments, are what the International Police Force must obtain from every nation if it is to fulfill its functions of preventing the atomic war.

The UN is Not Enough

At present there exists no International Police Force. It must, therefore, be immediately created. The United Nations is not such an International Police Force and at present shows no signs of becoming one.

The UN is based on the maintenance of national sovereignties which by definition must be impaired by an International Police Force. It is built on the unanimity Rule, or Veto principle, which prevents it from the beginning from dealing with any conflicts between the great powers from which alone the world war can come about.

Up to the present moment the International conferences have signally failed in every important task. When they were not engaged in dividing the world into spheres of interest as if to set the stage neatly for a coming conflict, they have engaged in sacrificing the democratic principles of the Atlantic Charter in appeasing increasing demands for more favorable strategic handicaps in such a coming conflict.

Peace is Still Possible

This completes the black side of the picture. It is our good fortune that on the other side there are three brighter facts on the basis of which it is possible to build world peace.

The first basic fact is that for several years the U.S. will be the only possessor of atomic bombs and, therefore, for that period, will not be forced to push the fatal buttons by the fear that an enemy might push its buttons first. We have several years of grace.

The second basic fact is that the U.S. is not tempted to use its great power to subject the world to itself for the sake of exploiting it for economic gain. We do not dream of using our power to lower the standard of living in the rest of the world for the sake of raising the standard of living for our own inhabitants. This has been demonstrated by the behavior of the U.S. since the end of the war. If we had any such ambitions we were then in a position to make the planet our own.

With the atom bomb to back our other forces, with our fully mobilized Army, Navy, and Air Force, and with the industrial armaments machine which had supplied not only ourselves but our allies in great measure, no one could have disputed any regime which we might have wanted to dictate to the world. Our demobilization at an unprecedented rate has demonstrated our peaceful intent to all. To all, that is, but those who see American imperialism in our not "giving the bomb" to Russia and who seem to think that peace would be served by our throwing away the years of grace.

The third basic fact is that the U.S. is by far the richest country in the world. We can afford to invest in the establishment of a permanent peace as much as we spent on the last war, and we can do this while maintaining and further raising the highest standard of living in the world.

The Solution

In the light of these three basic facts and in the light of the perilous international situation, I feel that I can discharge the responsibility that rests upon me as President of the United States of America at this most critical point in history, only by pressing with all the power at my disposal for the following policy:

1) I hereby propose that the United Nations constitute itself as an International Police Force with the minimum conditions for its effective operation as I have here outlined them.

This means removing the veto power from the UN and making such further changes in its constitution as are necessary to enable it to bring every nation under its authority. It means the transfer to the International Police Force of all heavy armament, including the atom bomb and complete control over their manufacture, their storage and the materials necessary for their manufacture. It also means that every nation must provide the fullest freedom of inspection to the agents of the UN and undertakes re-

sponsibilty for the establishment of the three fundamental freedoms throughout its territory.

(2) I propose that Russia be invited to draft a constitution for the International Police Force (as was originally suggested by Professor Einstein) which would satisfy these minimum requirements and which would give her any further safeguards she may desire, and that the U.S. delegation be instructed to accept all such safeguards unless they impede the working of the organization or are incompatible with the safety of other nations.

A World Peace Loan

As a further safeguard to Russia, and primarily in order to remove her suspicion that the capitalist world might combine to use the International Police Force to attack collectivist Russia, I propose the floating in the U.S. of a World Peace Loan of $250 billions over the next ten years, to finance the industrial development of all the backward and devastated areas of the world, up to $100 billions of this sum to be available for the peaceful development of Russia.

These loans would, of course, be conditional on the successful establishment of the International Police Force. They would be made only where they could earn interest at the rate of 3 per cent per annum. This means that they would materialize only where they would increase the productivity of the region where they are invested by more than enough to pay the interest and where there is a reasonable prospect of the country's being able to provide exports in the future sufficient to service at least the interest on the loan. No doubt many countries would want to borrow only if they saw a prospect of repaying the principal too within, say, fifty years, and in that case they would not borrow unless they saw a reasonable prospect of servicing the repayments as well as the interest.

In Russia, and in all parts of the world which are relatively poor in capital equipment, enormous amounts of capital can be invested to yield, in terms of the increase in output which the capital will make possible, vastly more than 3 per cent. The economic gain to the borrowing countries is measured by the excess of these yields over the 3 per cent they will have to pay to America.

Of course the whole scheme would be wrecked if we did not permit the borrowing countries to earn the dollars they will need for the interest payments and the capital repayments. The only way they can earn these dollars is by selling exports to us. We must, therefore, pledge ourselves not to impose any new restrictions on our imports direct or indirect; for only future large import surpluses can constitute the real repayments for our great export surpluses during the ten years or so of lending.

These interest payments and repayment of capital require no apologies here. They are of the essence of the plan. For however beneficial such a plan for the industrialization of the world would be for the populations which it would lift out of the misery of the ages, we must here consider it only from the point of view of its contribution toward dispelling the suspicions which are now hampering the establishment of peace.

What is relevant here is the recognition by the borrowing countries, and especially by Russia, that we will have a great stake in their continued prosperity. A large part of the standard of living of the American people will consist of our import surpluses from these countries. These countries would then know that America does not want to conspire with other capitalist countries to pervert the International Police Force into an anti-Russian instrument. The relevant purpose of the World Peace Loan is to show the Russians by this great investment in their economic reconstruction that we have no aggressive intentions but on the contrary are prepared to build up an enormous stake in the peaceful development of Russia and the rest of the world.

If UN Fails

But this is not the end of our troubles. For there can be no assurance that the United Nations will even agree to discuss such an establishment of the International Police Force. Or the United Nations may meet and various countries may deliberately prolong discussion while feverishly working on the manufacture of atomic bombs, planning to use these bombs to strengthen their bargaining power. If this happens the United Nations will indeed have performed the fatal function of hypnotizing us during the period of grace and delivering us to the fatal buttons of atomic preparedness.

I therefore propose further that if UN has not reached agreement on all the basic conditions within one hundred days, the U.S. shall proceed to join together with such other countries as will agree on a Peace Plan with the same basic conditions and fundamental freedoms and with the same plan for a World Peace Loan.

I do not think it would be many days before the greater part of the world will have come in. The plan can be put in motion as soon as another important country has joined with the U.S. Only in the case of Russia and the countries now being welded into the Russian sphere of influence is there likely to be any delay. But as soon as it is seen that the World Peace Loan promises rapid development and prosperity for those who join in the Peace Plan many countries now in the Russian sphere of interest will move over as soon as they can into the orbit of the American sponsored peace area.

Russia can be expected to hold out and perhaps to denounce the Peace Plan as an anti-Russian bloc. The only answer to this is to keep asking Russia to join on the same terms as the others.

The Ultimate Responsibility

If Russia or any other power should stay out of the Plan for as long as a year after its inauguration, which means not later than one year and a hundred days from now, this will have to be taken as *prima facie* evidence of aggressive intentions which would be thwarted by the inspection or other conditions of the Peace Plan. For if meanwhile the deadline is passed the world will once more be faced by the nightmare of the push-button war.

The International Police Force of those nations who are in the Plan must then be prepared to act. Every effort should be made to get the remaining countries to come in by non-military means. Intensive attempts should be made, for example, to reach the populations of such countries and to let them know the true nature of the proposals in case they are

(Continued on Page 126)

The International Control of Safe Atomic Energy

. . . by Cuthbert Daniel and Arthur M. Squires

♦ **Two engineers propose a compromise whereby the benefits of nuclear development may outweigh the risks.**

ARE THE BENEFITS of industrial atomic power worth the risk? We believe they are not. We believe that the problems of the international control of atomic energy can be reduced to manageable proportions only by an international agreement not to develop industrial atomic power for a generation. We believe that most of the foreseeable benefits of atomic energy to our generation can be had without its use for industrial power plants.

International control takes on quite different sense and seriousness for different parts of the field of atomic energy. Control of its use in scientific research and development is easy. A world control authority need place little check on properly designed experimental piles producing radioisotopes and intense radiation, or on the use of these isotopes and radiation in physical, chemical, and biological research. Laboratory reactors (e.g., those at Clinton Laboratories, Oak Ridge, and Argonne Laboratory, Chicago) require only small quantities of fissionable material, and produce plutonium usable in a bomb at a very small rate. Owing to fundamental construction features, the Clinton pile could make a bomb only after many years of production. To guarantee the safety of nuclear research laboratories, the world authority need only supply them with uranium, plutonium, and thorium according to their needs, and inspect them occasionally to insure legal use of these materials.

Control of the use of nuclear fuels to generate power is difficult. The existence of full-scale industrial power piles requires large-scale mining of uranium and thorium, and large-scale separation of U-235 and production of U-233 and plutonium. Their existence requires an extensive traffic in fissionable materials, large stockpiles, and high rates of production of materials usable in bombs. Their existence is attended by danger of illegal diversion of bomb material to small easily concealed bomb fabrication plants. It is generally recognized that power piles and the associated mining and production activities must be managed by a world agency, if the people of the world in which they exist are to feel secure against surprise atomic attack. National seizure of these plants and stockpiles is immediate cause for an international crisis, probably war, because of the short period (variously estimated at a few weeks to a year) in which a team of physicists and engineers can produce bombs from stock-piled material and new production. In short, nuclear power systems are the only part of the field of atomic energy for which it is true, as it is so often said of the whole field, that peace-time activities and war-time activities are eighty per cent identical.

Why then should industrial atomic power plants be built? To this question it is generally answered that man must not deprive himself of the benefits of the uses of atomic energy. These benefits, however, fall in two categories—those flowing from safe atomic science (including the industrial use of radioisotopes and pile radiation), and those from dangerous industrial atomic power. The prospects for these two categories are by no means equally impressive; in the words of the Secretary of War's Interim Committee on Atomic Energy, "It is probable that the exploitation of atomic energy as a tool for research will outweigh the benefits to be derived fom the availability of a new source of power."[1]

There is no doubt that the next twenty years of science will be more exciting and much more profitable because of the widespread availability of new powerful research tools stemming from laboratory piles. Fortunately, scientific uses of atomic energy involve no great danger to world peace and no major difficulties of inspection and control; nor do these uses now depend on the construction and operation of large-scale industrial plants, since stockpiles of enriched U-235 and plutonium now exist adequate to supply the world's laboratories during our lifetime.

Why are the benefits of scientific and industrial uses so closely associated in most discussions of nuclear developments? Most discussions make it appear that man must engage in *all* activities, going nearly up to bomb production, in order to secure *any* of the benefits. This is not the case. Safe atomic science, and the major benefits, can be had without dangerous atomic industrial development at this time.

Are the benefits of industrial atomic power worth the risks? The world must answer this serious question, and not be default. Our own answer is not based on private sources of information—we are not nuclear physicists; nor do we believe that inside technical information is necessary to judge this economic and political question. We have tried to form our opinion on the basis of all pertinent information which we or anyone else can properly secure.

A group of scientists and engineers working under C. A. Thomas reported to the United Nations Atomic Energy Commission that atomic power plants of a type similar to the Hanford piles can supply electricity at a price competitive

CUTHBERT DANIEL is a chemical engineer who was employed by the Kellex Corporation in the construction of the Gaseous Diffusion Plant at Oak Ridge and is at present concerned with the accounting of fissionable materials at the Carbide & Carbon Chemical Corporation there.

ARTHUR M. SQUIRES, a physical chemist, was also employed by the Kellex Corporation in the construction of the Gaseous Diffusion Plant at Oak Ridge and is now with Hydro Carbon Research, Inc., in New York City.

[1] Quoted by State Department Report on the International Control of Atomic Energy (the Lilienthal Committee), p. 19.

with electricity generated from coal costing $10 a ton.[2] (The average wholesale price of coal in the United States is about $5 a ton in normal times.) Such plants will burn natural uranium together with all plutonium produced as a by-product of power generation. Thomas' group emphasized the difficulty of the technological problems which must be solved before such plants can be built. We recognize that the report may be conservative from the long-range standpoint, since ultimately cheaper methods of power production may be developed which utilize a much higher percentage of U-238. On the other hand, it was reported by Wilmot, Minister of Supply in the British government, that "in some quarters the report is thought to be somewhat over-optimistic."[3]

The economic benefits foreseen for atomic power plants are a consequence of the negligible cost of transporting nuclear fuels. Plants can be built in regions remote from ordinary fuel deposits, and decentralization of industry can be effected by locating small atomic power plants at many points of a large electricity distribution network. J. Marschak, Professor of Economics at the University of Chicago, has called attention to the fact that the total cost of transporting fuel from mines to power stations generating electricity is a very small fraction of the entire United States national effort (about ⅛%); this cost amounts on the average to ⅛ cent per K.W.H.

If nuclear fuels were free and were capable of replacing coal in *all* its uses, the saving would be 2% of the national income. Professor Marschak pointed out, however, that no one can predict what new industrial combinations would arise from widespread use of atomic power. Like the automobile, which did not just replace carriages, atomic power might have far-reaching and unpredicted effects upon our entire technology.[4]

Atomic Power Not Feasible Now

It is generally agreed that many years must pass before atomic power can be used on a significant scale. H. A. Winne stated that "economically competitive atomic power" is "a long-term project, possibly requiring decades."[5] Its development then will have little economic effect during our generation, and cannot soon contribute to relief of the acute energy shortages current in some parts of the world.

It is difficult today to determine the potential long-range importance of nuclear fuels relative to coal as sources of energy. The U-235 in rich uranium deposits known before the war had an energy equivalent to only 0.014% of the world's total coal reserves.[6] It seems unlikely to us that new ore discoveries have increased this percentage by more than a factor of ten or so. Although the cost of recovering uranium from rich deposits is sufficiently low that its use is competitive with $10 coal, large-scale power production from U-235 would lead to quick exhaustion of rich deposits. As Fermi has indicated, "further production would have to use very poor ores with a consequent increase of several orders of magnitude in the cost of the primary material." The long-range importance of atomic power depends upon solution of the difficult problems associated with engineering power systems which utilize a high percentage of U-238.[7]

It seems likely to us that large-scale atomic power would not be developed in any country for many generations, if it were not for the direct or indirect support of the military in every major country. Atomic power is in a category with the airplane, whose rate of development was accelerated many-fold by military support: Development cost is high, prospects of early economic benefits are negligible, and long-range economic importance is problematical. The advantages of nuclear fuels are their small weight and bulk per B.T.U., advantages of great importance for military applications. The efficiency of nuclear fuels in battleship and submarine power plants and in rocket propulsion may well be decisive in military judgment, to which cost is often a minor consideration. Late in 1945, Langmuir pointed out that atomic power would probably first be used for naval ships, and that the field of atomic power would not be attractive to industry for a long time to come.[8]

There can be no criticism of the armed services for their intense interest in nuclear power piles, and in nuclear physics generally; the Army and Navy will be interested in all scientific development as long as there is need for an Army and Navy. Their interest in nuclear development will not decline appreciably with the advent of international control. Every effort will be made to determine the locations and capacities of power piles on strategic rather than economic grounds, even under international control. Persons who wish to see their country at a high pitch of military preparedness will regard with favor the large stockpiles of fissionable material at power plants, and will calculate the number of bombs which can be made from them in a crisis. This will be no less the case if these plants are managed by an international agency rather than by a national one.

Backwardness of Coal Technology

Comparisons of atomic power with coal power frequently ignore the backwardness of coal technology. Although Thomas has stated that the cost of coal energy is likely to increase, other engineers believe the opposite.[9] Chemical engineering techniques developed during the past twenty years by the oil industry are just beginning to find application to the problems of rational utilization of coal; methods of producing high B.T.U. gas from coal and transporting the gas in pipelines promise large reductions in the cost of coal energy to consumers remote from mines. Moreover, many believe that modern mechanical engineering can appreciably reduce the cost of mining coal. The open-cycle coal-fired gas turbine is

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[2] The International Control of Atomic Energy: Scientific Information Transmitted to the United Nations Atomic Energy Commission. IV. Nuclear Power (Sept. 5, 1946).

[3] Bulletin of Atomic Scientists, Vol. 3, No. 2, p. 52 (Feb., 1947).

[4] Ibid., Vol. 2, No. 5 and 6, p. 8 (Sept., 1946).

[5] Reported in New York Times, March 19, 1947.

[6] One World or None, Chapter 4 (Gale Young).

[7] Chemical and Engineering News, Vol. 24, p. 1357 (May 25, 1946).

[8] Hearings before the Special Committee on Atomic Energy, United States Senate, 79th Congress, 1st Session, p. 109 (Nov. 30, 1945).

[9] P. C. Keith, Chemical Engineering, December, 1946, p. 101; see also Fortune, March, 1947, p. 85, for the first of a series of three articles on coal technology.

already at an advanced stage of development in this country, where it promises to be of use in locomotives. This engine is also well adapted to isolated, waterless locations, and may make possible a great increase in power production wherever water availability is now the limiting factor.[10]

It is apparent that large gains in economy of coal utilization can be achieved by a modest expenditure of technical and industrial effort. We suspect that a rational effort to increase the world's power supply during the next several generations, to decentralize industry, and to industrialize remote regions, would concentrate on exploitation of water power, on improvements in utilization and transportation of coal energy, and on the gas turbine, and not on industrial use of nuclear fuels. We suspect this to be true realizing that we do not possess all information necessary for a definitive judgment. We suspect that pipe-line gas or water power will prove to be the cheapest energy for most regions where power is now expensive, such as the Mediterranean Basin, California, and the South of China. Many of these regions would not be helped greatly by atomic power development under an international control authority, since in many instances nuclear power systems of economic importance would be denied because of their military threat.

England, France, and Russia all stand in greater need of an increased power supply than the United States; a given expenditure of technical and industrial effort directed toward the generation of electricity from nuclear fuels will produce results of far less economic importance for these countries, in our opinion, than an equivalent effort directed toward improved mining and gasification of coal and the manufacture of high B.T.U. gas and liquid fuels.

Are the benefits of industrial power worth the risks? The commonest of all errors of judgment, we suppose, is to consider the palpable advantage more important than the latent danger. But the presence in every major country of 80% of the operations required to make atomic bombs seems to us greatly to increase the likelihood that sooner or later, under the present world conditions of national sovereignty and mutual distrust, some country will make bombs.

The predicted benefits of industrial atomic power should not impress us. Even if these predictions underestimate the facts, and it actually were possible to enjoy large-scale economic use of atomic power in our lifetime, still mankind can afford to wait a generation—let us hope, in peace—for new atomic industrial frontiers on mountain and desert, for space ships, and the like. We believe that there should be international control of *safe* atomic energy activities, and international prohibition of dangerous activities until the world's people learn the limitations of nationalism and the advantages of working together. In the words of Professor Marschak, "Reaching for a few strawberries on the edge of a precipice we may fall and break our necks."

A Compromise Proposal

There can be no doubt that the Russians and Americans are poles apart in their points of view on atomic energy control. Let us not be unduly discouraged by March's news or unduly encouraged by December's. There will be no real hope for an effective pact establishing the international control of atomic energy until a basis of agreement between these two great protagonists has been found. Russia demands immediate destruction of all atomic bombs followed by inspection with a minimum of interference with national institutions. America requires an operating system of international inspection before full transfer of present United States plants to the world control authority; the authority will be responsible for the management of all such plants in every country. The Russians feel management to be a degree of control which interferes intolerably with national life.

Clearly no golden-mean is possible between these two irreconcilable positions. The irreconcilability is aggravated by the deep conviction on each side that the other is trying to outmaneuver, surround, and eventually overpower it.

Usually compromise is reached by each side's giving up part of its position. Tit for tat. In this case, we propose that both sides give up the same thing, for the same reason. We propose a compromise whereby the principal tool of military power is removed from the hands of both sides, by agreement, without loss of the foreseeable benefits of nuclear science to either side. Whether a plan for international control of atomic energy is adopted or not, equality in atomic military potential is eventually inevitable. Equality in this field is most advantageous when both sides of the equation are set equal to zero. The advantage to the people of the world becomes less, the higher the military potential. At some point national equality becomes dangerous national rivalry.

The plan now under discussion by the United Nations[11] calls for construction of dangerous atomic production plants in many nations, while the United States gives up only the bomb fabrication phase of its current activities. Thus the atomic military potential of all major nations will be equalized nearly at the present high level of the United States. If no industrial plants are permitted to exist, national rivalry in the field of atomic energy is reduced to a rivalry in the quality and size of the staff of research and development experts who can activate a bomb project.

The experience of the armament race leading to 1914 indicates that the likelihood of war is greater the higher the general level of military potential. It is clear that industrial atomic facilities raise a nation's military potential, whether managed by a world control agency or not. We propose to do more than remove the threat of surprise atomic attack; we propose to minimize the danger of atomic war.

We propose the following compromise between the Russian and American positions: Let there be a world agreement that no new industrial atomic plants shall be built anywhere in the world for a number of years. Let there be established an Atomic Development Authority along the lines proposed by the United States, with responsibility for world geological surveys, inspection against illegal activities leading toward bomb manufacture, and operation of laboratories for nuclear research and pilot plants for development

[10] J. I. Yellott, American Institute of Mining and Metallurgical Engineers, Technical Publication No. 2086 (August, 1946).

[11] Bulletin of the Atomic Scientists, Vol. 3, No. 1, p. 16 (Jan., 1947).

of methods of U-235 enrichment and plutonium production.

The Authority will estimate the quantity of enriched U-235 and plutonium required for research and development activities during the next twenty or so years, and draw plans for its distribution to research stations throughout the world. Enriched material now existing in excess of this quantity will be destroyed. The size of research and development piles will be set so that the rate of production and the inventory of material usable in bombs within each nation are below agreed-upon limits. We believe that limits can be set which permit a large-scale research effort with no danger to peace.

All pilot plant studies of fissionable material production and of power generation will be undertaken by the Authority; since the men who make the studies will be viewed as military assets by groups planning to seize military power, these men should come under close international surveillance.

As soon as there is established an inspection system which provides safeguards agreed on previously, the United States will dismantle its large-scale production plants (K-25 and Y-12 at Oak Ridge and the plutonium piles at Hanford), permit the distribution of fissionable material for research, and publish all significant scientific and technical information, from mining to bomb design. When the supply of fissionable material for research is exhausted, let the nations agree upon the operation of a single small U-235 separation plant and a pile to provide material for experimentation at the required rate. (If after ten to twenty years the nations cannot so agree, there will be far more serious things to worry about than the shortage of U-235 and plutonium for research.)

Powers of Atomic Development Authority

Under our proposal, neither the Atomic Development Authority nor any other person will have the power to mine and process uranium and thorium on a large scale (beyond needs of laboratory and ordinary commercial users); to operate reactors or separation plants which produce large quantities of material usable in bombs or which, by relatively minor operational changes, could make material for bombs; to operate facilities for making atomic weapons or for research and development in military uses of atomic energy—these activities, let the world agree, are too dangerous for our time, since they guarantee national rivalry in the field of atomic energy at an extremely dangerous level. Let us spend our time in world education and political development so that future generations will not know fear.

Our proposal contains little that is new. It is a modification of the plan proposed by the Lilienthal Committee, and indeed may be regarded as a proposal concerning the steps whereby the Lilienthal Committee's plan may ultimately be put in effect when world conditions permit. In the fall of 1945, Urey, Langmuir, Szilard and others, while testifying before the Senate's Atomic Energy Committee, expressed their willingness to delay the development of atomic power, if delay would make war less likely. The authors of the Chicago Draft Convention[12] proposed a five-year delay in construction of large-scale power plants; during this time the international agency would carry out pilot plant studies to determine plant designs which make control easy and sure.

We add two requirements: (1) that the present United States plants be destroyed, since if they are not other countries will wish similar plants immediately, even if construction of power plants is delayed; and (2) that the exploitation of atomic power be postponed until the world can use it safely.

Our proposal is in the interest of the people of the United States. To persuade them of the fact may be difficult. On the surface it appears that our proposal requires America to give up much which she would keep under the present United States plan. It will require a more extensive and serious educational campaign in this country than is now in progress to explain that our temporary atomic military superiority is a potential hazard, and not an advantage, either strategically or as a "bargaining point." Today this superiority is perhaps the greatest single stimulus for an atomic armaments race. Tomorrow the superiority will vanish. If atomic equality is reached after an armaments race, or after a program of construction of atomic industries in other countries under the present United States plan, the American people will be exposed to greater threat of war than if our proposal is adopted.

The United States can progress toward international cooperation only by courageous display of farsightedness. It cannot throw away its present atomic military superiority before a control agreement is reached, but it should clearly express willingness to destroy the plants and stockpiles which constitute this superiority. The people of the United States must learn to prefer an atomic agreement which does not put nearly complete atomic bomb plants in every major country. They will suffer no hardship if our present atomic plants are dismantled and if no industrial atomic power plants, battleships, or rockets are built. No country is less in need of a new and expensive fuel than the United States. We believe there are more profitable tasks for this country's staff of technical men, now in short supply because of the war, than work on nuclear power systems.

Although it is difficult to analyze the motives of the Russian leaders, it appears to us that our proposal has many advantages to them. The present superiority of the United States makes their discussion of the United States plan difficult. They are unwilling to contemplate a situation in which the combined atomic production capacity of non-Russian states exceeds the capacity of Russia and her satellites, yet they cannot hope to secure agreement to a disposition of production plants in which this is not the case. If the United States plan is adopted, Russia must expand a large technical and industrial effort to match America's present production plants and stockpiles. In addition, the Russian leaders must use valuable personnel to lay plans and train men for the militarization of Authority facilities in the event of war. All of this must be done if Russia is to feel "secure", however questionable security based on competitive preparations for atomic war may be.

Under our proposal, Russia's leaders will be assured, by an inspection system partly under their control, that no such competition is needed. Russia's (and every country's) security is complete as

[12] Ibid., Vol. 1, No. 8, p. 11 (April 1, 1946).

soon as the United States reveals its know-how, scatters its stocks of fissionable materials, and dismantles its plants. Russia can then use its scientific and engineering staff for more constructive tasks than duplication of America's atomic facilities.

Inspection Easier

The Lilienthal Committee pointed out that " it is far easier to discover an operation that should not be going on at all than to determine whether a lawful operation is being conducted in an unlawful manner."[13] Inspection is easier under our proposal because there are fewer lawful operations than there are under the United States plan. Our proposal requires an inspection system which will detect the existence of unlawful large-scale mining operations, large-scale processing of uranium and thorium, manufacture of nuclear fuels, and bomb fabrication. The only lawful operations are small-scale laboratory use of fissionable materials and possibly small-scale mining. A high degree of assurance that attempts to obtain bombs must fail is afforded under our proposal by a careful geological survey of the world for deposits of uranium and thorium, followed by a continuous watch of all known deposits. Experts generally agree that such a survey and watch has a high probability of success.[14] The United States plan requires not only an inspection system to detect the unauthorized existence of all operations from mine to bomb, but also a system to insure that all authorized mines and plants for processing, manufacture and use of nuclear fuels are operated without illegal diversion of material in amounts dangerous to peace. Every nation will demand assurance that dangerous plants in all other countries are legally operated. In addition, private vendors of graphite for Authority piles, of diffusion membrane, centrifugal pumps, and control instruments for Authority gaseous diffusion plants, etc. must be carefully watched to prevent production of undeclared goods and their shipment to illegal plant-sites. (Under our proposal the manufacture of these unusual materials on a scale unwarranted by their limited commercial use constitutes a danger signal.) Because of the scale of the effort required to construct an atomic industry, a large fraction of the industrial know-how can never be under direct Authority control, and so much come under close Authority surveillance.

We believe that there has been insufficient emphasis on the difficulties of assuring that large industrial plants are legally operated. The problems of material accounting will assume nightmarish proportion when the world's rate of production of fissionable material becomes many times the present productivity of Oak Ridge and Hanford, so that very small percentagewise losses become potentially very hazardous.

Some may argue that under our proposal there is greater temptation to attempt an illegal bomb production program, since success finds the criminals with great relative strength when no one else is engaged in industrial activities leading nearly to bomb assembly. Against this argument we must set the temptation under the United States plan to misuse or seize dangerous industrial facilities. We believe that an inspection system can give more positive assurance that no large-scale illegal bomb programs exist than that no fissionable material is diverted to small hidden bomb assembly plants, or that groups do not plan seizures.

The Lilienthal Committee emphasized the fact that first rank scientists and engineers, the only people competent to direct an inspection force, will not choose to serve on a purely negative, police-like inspection force. Our proposal calls for a world authority with no purely operating jobs, fewer police jobs than are called for by the plan proposed originally by the Lilienthal Committee and now under consideration by the United Nations, and the same number of interesting research and developmental jobs. The men needed to direct an inspection force will be attracted and stimulated by research, development, and pilot plant activities of the Authority; they are not much interested in the operation and control of large plants or the mass procurement of materials of construction. The job of inspection is largely one of imagination, a job of guessing the manifold forms which an illegal plant might take, the substitute materials, the dodges.

Enforcement Less Likely to Mean War

Under the United States plan the most probable form of violation of the atomic control agreement is the seizure of Atomic Development Authority plants and stockpiles, an action highly likely to succeed. Even when persons are caught diverting material to hidden bomb-sites or mining illegally or building plants, they are likely to attempt seizure of the nearest Authority plants in an effort to carry through their jeopardized plan of world conquest. Each country will prepare plans and staffs for the seizures and rapid militarization of Authority plants; it will do this in self defense against the day another country acts. Leaks of information about these plans and staffs will contribute to international tensions.

Minorities eager for political power will be likely to urge seizure, an overnight task tempting in its apparent sudden increase in national military advantage. Public and technical support for seizure will be easier to obtain than support for a program of building bomb plants from scratch, since the latter requires years before military advantage is secured. In the crisis following seizure, successful fabrication of second-rate bombs—second-rate, that is, relative to those used in August, 1945—from denatured material is not much less serious than fabrication of first-rate bombs.

When a group seizes Authority plants and stockpiles within a country, it is likely that the only means of punishment available to the Authority is a request for other countries to declare war on the offending nation. Thus, even though the people of the country are not in sympathy with the seizure prior to its occurrence, they will probably be forced to unite behind the criminals in mutual defense against the violence of the attack from without.

Under our proposal, since no legal industrial plants exist, the crimes of their seizure or misuse cannot occur. Persons who would make bombs must secretly engage in all activities from mine to bomb, and the likelihood of success is small.

There is a good chance that punishment of all crimes possible under our proposal can rest on prosecution of individuals in

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[13] Reference (1), p. 34.

[14] Jerome Fisher, Bulletin of Atomic Scientists, Vol. 1, No. 5, p. 1 (Feb. 15, 1946); Report on Control of Mineral Production by Committee under Chairmanship of P. F. Kerr, ibid., Vol. 1, No. 6, p. 4 (March 1, 1946).

courts of law. At the first sign of the opening of a mine, the construction of an illegal plant, or the misuse of a laboratory device, the Atomic Development Authority can issue a warrant for the arrest of all persons with knowledge of the illegal activity, so that they can be arraigned before an international court of law.

A Manageable Step Toward World Government

Atomic energy control must be a first step in the evolution of the United Nations toward world government and complete disarmament.

We believe that the United Nations, as presently organized, is too weak to assume the grave responsibilities of atomic energy control according to the present United States plan. This plan in our opinion requires full world government based on a strong habit of peace. The United Nations shows little sign today of moving toward peace; the nations show little sign of wishing to disarm. It is hard to imagine countries giving up other capital weapons unless they are disarmed atomically. Rather, each nation will argue a sacred duty to maintain a military establishment to protect the vital industrial plants of the Atomic Development Authority within its borders.

There has been little discussion of the steps leading to international control by the United States plan, but it may be safely predicted that no major nation will be satisfied with any other nation's plan for the locations, capacities, and start-up dates of large U-235 separation plants and plutonium reactors, for mining quotas, ore shipments, stockpiles of enriched material, etc. Persons who speak of a strategic balance in the geographical distribution of plants and stockpiles raise questions only of their own disingenuousness—a way has not yet been found to slice a pie five ways so that each single piece is larger than the other four put together.

There is good historical evidence that reliance on balance of power to preserve peace, when nations mistrust each other, actually makes war more likely. If roughly equivalent atomic energy installations are located in many countries (possibly along with a few atomic bombs, as sometimes suggested), in the hope that overwhelming strength will remain with the law-abiding in the event of a violation of the atomic energy agreement, one can be fairly sure that no violations will occur until a number of countries have been lined up in a coalition. In fact, there will be an intense diplomatic effort to form opposing parties of nations, i.e., to establish a balance of power between two groups. One can also be fairly sure that shortly after opposing groups of nations are organized, all countries in one bloc will, as if by coincidence, violate the atomic energy agreement simultaneously. Simultaneous seizure of Authority plants and stockpiles can easily be arranged and takes a few hours to execute. Simultaneous violations are far less likely if no industrial atomic energy plants exist, since operations leading to the undetected manufacture of atomic bombs take years and are unlikely to be attempted by a number of countries at the same time.

Shall There Never Be Industrial Atomic Power

Some may argue that our proposal places an intolerable restriction on human progress; that man in his conquest of nature is fated to exploit large-scale atomic power, and no turning aside or delay of fate's processes is morally acceptable. In the words of the Lilienthal Committee, the argument is that "any effort to confine the inquiring mind . . . is doomed to failure," and that "the very existence of a prohibition against the use of piles to produce fissionable material suitable for bombs would tend to stimulate and encourage surreptitious evasions."[15] This argument makes humanists of power pile designers, and of us, advocates of medieval reaction.

We believe that it is both desirable and possible to place limitations on human inquiry. A psychologist who wishes to study panic would learn much by setting fires to theatres. This is a method of investigation which is forbidden to the humane scientist. Progress in this field of psychology is desirable, but must proceed at the slow pace set by accidental discovery (as by a psychologist who by chance can observe panic during a theatre fire). It is easy to think of other examples. We believe that for our generation any information which can be obtained from large-scale atomic power plants (and which cannot be obtained from pilot plants) is not worth the probable price in human suffering.

Engineering experience generally suggests the unlikelihood of additions to scientific knowledge as a direct result of large-scale industrial activity. Industrial installations are usually poor experimental tools, because their construction is necessarily conservative and the range of operating variables limited. It is conceivable that a purely scientific enterprise may require the construction of a pile which produces bomb material at a dangerous rate. If the experiment can be performed quickly, so that there is no dangerous accumulation of bomb material, it may be possible to secure international agreement to construct one such pile, operate it for a short time, and destroy it. But if the enterprise requires long-term operation of such a pile, we believe that our generation should forego the information which the enterprise could yield.

We do not propose that industrial atomic power never be developed; it is probably a long-term good. As other sources of energy become depleted and as the habits of peace become strong, the advantage of atomic power will become greater and the danger less.

In making a judgment on a foreseeable social change of the magnitude of that promised by the development of nuclear power, it is important to consider path and method even more carefully than goals and outcomes. The history of social programs and plans shows many sad examples of the failure to consider means along with ends. The communist experiment will not, we fear, be the last horrid example. The attempt to force technological change, just because the physicists have said 'Ready', leaves out the other crucial prerequisites of a successful, socially advantageous development.

The Tennessee Valley Authority shows how the Atomic Development Authority should proceed. The technical methods of flood and erosion control, power and fertilizer production, and scientific farming were ready for large-scale application long ago. An attempt to force immediate use of these methods, without preparatory education, would have failed. Such

(Continued on Page 135)

[15] Reference (1), pp. 17 and 21.

Economic Aspects of Atomic Energy as a Source of Power*

A Discussion of the Estimated Costs of Atomic Power and of the Economic Factors Which May Affect Its Use

... by Sam H. Schurr

(The following article is based on a speech delivered at the meeting of the American Economics Association at Atlantic City on January 23.)

THE POSSIBLE USE of fissionable substances as a new and important source of energy gives rise to a number of economic questions. This paper deals in a very general way with two sets of questions: (a) those related to the comparative costs of producing energy from atomic fuels and other sources; and (b) those related to the economic consequences which might follow the introduction and use of atomic fuels. The discussion is built around examples which illustrate each of the questions considered.

I—The Comparative Costs of Power from Atomic and Non-Atomic Sources

Energy is developed in the atomic pile in the form of heat. The heat produced might possibly be consumed directly in a variety of industrial and non-industrial uses requiring either low or high-temperature heat. In the light of what is known of current research on peacetime applications of atomic power, it is probable that the earliest important use of the heat produced in the pile will be in the generation of electricity. It is for this reason that such estimates as have been made of the cost of energy from atomic sources have been for the generation of electric power. This paper, similarly, is limited to a discussion of atomic energy as a source of electric power.

Electricity is, at the present time, generally produced most cheaply in large hydroelectric developments.[1] One important factor to notice in connection with water power is that it exists only where natural conditions permit, and that it is not considered economically feasible to transmit the electricity produced beyond a radius of about 300 miles.[2] The cost of electricity based on a fuel such as coal is generally higher than for hydroelectric power, but such fuels are very widely used because they can be transported to the power station, wherever located.

The transportation of ordinary fuels is, however, costly; for example, each 200 miles of coal transportation by rail adds about 1 mill per kilowatt hour to the cost of electricity so that generating costs in a power station located 400 miles from a coal mine might be greater by about 30% than in a station at the mine mouth, as a result of the cost of coal shipment on railroads.[3] When we consider that one lb. of atomic fuel yields about as much energy as 2 1/2 million lbs. of coal it is clear that, by ordinary standards, the cost of transporting atomic fuel will be infinitesimal. As a result nuclear power costs will for similar plants be fairly uniform throughout the world.

Estimated Cost of Atomic Power

What, then, are the costs of producing atomic power? The most authoritative publicly available estimate of costs is that derived by a group working at Oak Ridge under the direction of Dr. C. A. Thomas,[4] Vice-President of the Monsanto Chemical Company. According to this study a power plant based on atomic fuel could generate electricity at a cost of about 8 mills per kilowatt hour, if operated at 100 per cent of capacity. Because of the nature of their demand, power stations normally operate at no more than about 50 per cent of capacity; we have, therefore, reconstructed the Thomas figure on the basis of operations at 50 per cent of capacity, and have derived an estimated cost of about 10 mills per kilowatt hour.

A lower cost for atomic power was derived by a group working under the direction of Professor Condliffe at the University of California.[5] They estimated that the same general type of plant as was assumed by the Thomas group might produce electricity for as little as 4 mills per kilowatt hour, operating at about 45 per cent of capacity. This compares with a cost of about 10 mills in the Thomas report.

Both estimates are surrounded by a wide area of uncertainty because the future cost both of constructing atomic plants and producing fissionable materials can be estimated only within broad limits. Despite the uncertainties, it is possible to isolate one factor which may account for at least part of the difference between them. Thus, the estimate of the Thomas group is for a plant with a capacity of 75,000 kilowatts, while the California estimate is for a plant of 500,000 kilowatts.

The California study indicates that a part of the investment in an atomic power plant would be for special instruments and controls, and that their costs would not vary in the same proportion as size of plant. As a result, the larger plant assumed in the California study might be expected to produce electricity at a substantially lower cost than the smaller plant assumed in the Thomas report.

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SAM H. SCHURR is a Co-director of the study of Economic Aspects of Atomic Energy being conducted by the Cowles Commission at the University of Chicago.

1 For data supporting this generalization see Gordon, Lincoln, "Power and Fuels" in *Industrial Location and National Resources*, National Resources Planning Board, December, 1942.

2 Watson, J. P., "Potential Waterpower in the United States" in *Energy Resources and National Policy*, National Resources Committee, January, 1939.

3 Based on data in I.C.C. *Reports*, Vol. 69, p. 18; *Electrical World*, Dec. 2, 1939, "4th Steam Station Cost Survey"; and Bauer, John and Gold, Nathaniel, *The Electric Power Industry*, Harper, 1939.

4 *Nuclear Power*, Scientific Information Transmitted to the United Nations Atomic Energy Commission by the United States Representative, Vol. IV, September 5, 1946.

5 "Atomic Energy, Its Future in Power Production," *Chemical Engineering*, October, 1946.

The two estimates may, therefore, be taken to suggest that the cost of generating electricity in atomic power plants may be somewhere between 4 mills and 10 mills per kilowatt hour, or possibly somewhat beyond this range. Table I summarizes our estimates of electric generating costs for selected regions in 1937, a prewar normal year, and 1947, in those cases where data are available. The regions have been chosen to represent varying patterns of energy resource occurance and use.

For every region covered the costs of electricity are within or above the range of atomic power costs we use. This could be taken to indicate that atomic plants of a size assumed in the California study could produce electricity more cheaply than some of the power stations currently in operation in all countries. However, such stations would probably be so large that few, if any, locations could absorb the electricity produced, considering the feasible limits of transmission.

For example, a 500,000 kilowatt plant, which is the size assumed in the California study, produces enough electricity to satisfy an industrialized region of about one million population. As estimated coal-electricity costs approach the upper limit of the range of atomic costs, or go beyond it, this qualification becomes less important, for this can be taken to indicate that even more moderately-sized atomic power plants might produce electricity more cheaply than coal plants.

The highest and lowest level of generating costs in the countries covered in Table I are for Argentina and the United States respectively. This is to be expected since Argentina is an outstanding example of a country poor in energy resources which must import fuel from extremely distant sources of supply, while the United States is an outstanding example of a country with abundant fuel resources. Nevertheless, even in the United States costs approach the upper limit of the range of atomic costs in certain parts of Minnesota, South Dakota and Wisconsin.

Costs throughout Argentina in 1937 were in the neighborhood of the upper end of the range of atomic costs; currently, costs throughout Argentina are considerably beyond the highest estimate of atomic costs, as a result of the world wide shortage of coal and shipping. If post-war normal electricity generating costs in Argentina are somewhere between costs in 1937 and 1947, the savings which might be possible through the use of atomic energy appear to be considerable.

Other regions with generating costs approaching the upper end of the range of atomic costs and, therefore, exemplifying places where atomic power may be economically feasible, are Hungary, and areas remote from coal mines in India and China. Hungary uses domestically-mined fuel for the generation of electricity and the high costs are explained by the fact that the fuel is poor in quality and costly to mine. In China and India the level of electric generating costs in regions remote from energy resources is relatively high as a result of coal transportation; the highest costs in India are above those in China because mines are more highly localized in India.

The position of Great Britain differs from that of the other regions covered. It has traditionally been an important producer and exporter of coal, and there are few regions in that country remote from sources of energy. This condition was reflected in moderate costs of electricity as shown in Table I for 1937. However, generating costs are considerably higher in 1947 than they were in 1937 as a result of increases in the costs of mining coal between the two years.

In part these increases have resulted from temporary dislocations brought on by the war; in part, there has been a long run tendency towards increasing costs in the British coal industry as a result of an insufficient degree of mechanization and modernization of coal mines to counteract the decline in the grade of coal resources. Whether coal costs will fall in the future, and by how much, will depend on the success the British have in carrying through modernization of their coal industry; if they do not experience a high degree of success, atomic energy may prove to be a cheaper source of electricity than coal.

TABLE I

Estimated costs of generating electricity in selected regions of the world, 1937 and 1947, compared with estimated costs of atomic power.

	Average Generating Costs in Mills per Kilowatt Hours.[1]		Cost of Atomic Power in Mills per Kilowatt Hour.
	1937	1947	
Thomas Report			8.0-10.0[2]
California Report			4.0[3]
Argentina			
Coastal regions	9.0	16.0	
Inland regions	10.0-11.0	17.0-18.0	
China			
Mining regions	6.5-7.0	—	
Other regions	7.0-9.0	—	
Great Britain	7.25	9.5	
Hungary	9.25	—	
India			
Mining regions	6.5-7.5	—	
Other regions	7.5-10.0	—	
Soviet Union[4]			
Ural region	6.5	—	
United States[5]			
At mines	5.50-6.25	5.75-6.75	
Near mines or on developed waterways	6.50-7.25	7.00-8.25	
Far from mines, accessable by rail	7.50-8.75	8.50-9.50	

[1] In order to place all electricity costs on a comparable technological base, we do not show data on actual generating costs since these would be influenced by the condition of the plants in operation. Instead we have estimated electric generating costs from the cost of fuel in the various regions, assuming the same relationship between fuel costs and generating costs as would obtain in a modern 100,000 kilowatt plant operating wih a 50 percent load factor. (Based on data in *Electrical World*, December 2, 1939, "4th Steam Station Cost Survey," and Bauer and Gold, op.cit.) All coal prices include cost at mine and transportation charges. Transport costs from mines to consuming regions estimated from representative railway, river, and ocean freight charges.

[2] 75,000 kilowatt plant assumed. Lower cost based on 100 percent load factor; higher cost estimated by us for 50 percent load factor.

[3] 500,000 kilowatt plant and 45 percent load factor assumed.

[4] Data on mining costs could not be found for this region, hence U. S. mine price was used.

[5] Coal plants only. Generating costs estimated on basis of standard relationship described in footnote (c). Earlier figures relate to 1938 and are based on data on actual fuel costs for plants in operation in that year. Figures for 1947 are preliminary estimates derived by us from general information on current coal prices and freight rates.

The Ural region of the Soviet Union typifies still another situation. The cost of generating electricity in this region is estimated at a level about midway between the two estimates of atomic costs, which suggests that the use of atomic power may be of questionable economic benefit. The relatively low level of costs results from the current use of locally mined coal and lignite for electric power generation.[6]

There is evidence, however, that any substantial expansion of electrification in this region would require that coal be sent from other parts of the Soviet Union. We estimate that such additional amounts of electricity would cost between 9.0 and 9.5 mills per kilowatt hour—a level not far below the upper end of the range of atomic costs. Atomic energy might provide the additional power at a lower cost.

Other Factors Affecting Costs

Before concluding the analysis of the comparative costs of power from atomic and non-atomic sources, two additional factors which might favor the position of atomic power should be considered. The estimates of atomic power costs are for a technology on the threshold of development. Great declines in cost may be possible in the future as a result of advances in techniques of constructing and operating piles, and of producing fissionable materials. Electricity based on coal represents an established technology which probably will not undergo radical change to nearly the same extent.

The second factor to consider is that for such countries as China, India, Great Britain and the Soviet Union, the saving involved in introducing atomic energy can not be assessed merely by comparing the current level of costs of producing power from atomic and non-atomic sources.

To a certain extent expanded electrification in each of these countries would require considerable investment of capital in the development of energy resources: England may be able to buy cheaper electricity in the future at the cost of large scale investment in the modernization of coal mines; China, India and the Soviet Union may be able to expand electrification through hydroelectric development or by the development of new coal mines and the modernization of old ones. Atomic nergy, either alone or in conjunction with other energy resources, might possibly offer a faster route to expanded electrification or one requiring a smaller total investment of capital.

II—Economic Effects of the Use of Atomic Energy

On the basis of the comparative costs of producing electricity from atomic and non-atomic sources, it appears possible that atomic fuels may replace or supplement existing sources of power in some parts of the world at an early date. The affected regions will not necessarily be areas remote from existing energy resources as can be seen from the fact that atomic energy may prove cheaper than coal in a country like Great Britain.

The figures presented above are, however, purely suggestive and it would be incorrect to draw any hard and fast conclusions with respect to specific areas from them. As a result, our discussion of the economic effects of the use of atomic energy is not limited to the specific areas for which data are shown above. We consider first the savings which might be involved in replacing fuels currently used in the generation of electric power by atomic energy; and, second, the unique developmental possibilities opened up by atomic power.

The total saving in an economy such as our own as a result of the use of cheaper fuel in electricity generation, may be seen from the following overall figures. The amount of fuel consumed in the United States in 1942 for the generation of electricity by central stations was about 80 million tons of bituminous coal equivalents.[7] If we assign an average value of $6 per ton of coal equivalents at the power station, we get a total value of about $500 million for fuel consumed by the electric utilities. This figure could be increased to include fuel consumed by certain industrial establishments in the generation of their own power, and it would still come to no more than a fraction of 1 per cent of our total national income of about $150 billion.

Thus, if all the fuel currently used in the generation of electric power were replaced by a fuel which costs nothing the savings in our economy would be very small. The savings per unit of electricity would be greater for countries in which fuel costs are higher than in the United States, but few of these countries are power-based to anything like the same extent as the United States.

Broader Economic Effects

Obviously, however, this type of calculation does not provide a measure of the full economic effect to be expected from the possible cheapening of power through the introduction of atomic energy, nor is it even a measure of the major economic effect. For the major economic importance of the cheapening of power in any part of the world is to be found not in the cost-reducing effects, as such, but in the growth in economic activities which may result therefrom. In one sense the large-scale development of hydroelectric power by the TVA merely reduced the cost of power in the Tennessee Valley, but we do not think of this saving as a full measure of the economic effects of TVA, because the principle effect of cheap power has been to expand the economic life of the region.

The domestic demand for electricity has grown as a result of cheaper rates, and has brought with it the extended wiring of homes, the introduction of new electrical appliances in the home and on the farm, the proliferation of service activities related to electrification, etc. Cheap power also encouraged greater industrialization by making new combinations of productive factors economically feasible. The industries developed in the first instance as a result of the availability of cheap power have been electroprocess industries which, in turn, have served to attract a variety of secondary industries. These developments and many more tended to reinforce one another and merge in a general process of growth.[8]

Similar developments on a varying scale could occur elsewhere as a result of the cheapening of power. The number of areas opened up to this kind of development by

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6 In addition, as noted in Table I, in the absence of data on actual mining costs in this region, we were forced to fall back on estimates based on United States experience. Actual costs in the area, therefore, may be higher than the costs we show. Similarly, the estimated costs of electricity based on coal shipped from other parts of the Soviet Union may be too low.

7 Gould, J. M., *Output and Productivity in the Electric and Gas Utilities*, National Bureau of Economic Research, 1946, p. 163.

8 Lilienthal, David E., *TVA Democracy on the March*, Harper, 1944.

atomic energy are very much greater than with other energy resources because it is not bound to a specific site in the manner of water-power, nor is it costly to transport in the manner of ordinary fuels. Thus, one of the great promises of atomic energy lies in the development of regions remote from other energy resources. In such cases the important effect is to be sought in the pervasive influence of power in the economic development of an entire region as in the Tennessee Valley, rather than in the savings involved in substituting one source of power for another.

We must note, too, that our calculation of the overall savings involved in the possible cheapening of power obscures the differential importance of atomic energy in the development of specific industries. It is to be expected that in an advanced economy, such as our own, the impact of atomic power will be felt largely through its effects on the important energy-consuming industries.

Costs in such industries might be reduced substantially either through the use of cheaper power in present locations; or through the location of production in new centers in which atomic fuel is brought to raw materials, which, in the past, had to be shipped to fuel for processing; or through a combination of the two causes. Examples of industries in which location of production, costs of production, or both could be affected by the advent of atomic power include the electroprocess industries such as aluminum, ferroalloys, and chlorine; and important heat consuming industries such as metal smelting, cement, glass, clay products, and pulp and paper.

To illustrate, specifically, the type of development which could result from the use of atomic power, we consider its possible significance for aluminum, an important electroprocess industry. Table II presents data on those components of costs in the production of aluminum which might be affected by atomic power.

Since power accounts for roughly 20 per cent of the cost of pig aluminum, it is clear that a substantial reduction in total costs could be achieved through reductions in power costs. Because their power requirements are so great, aluminum reduction plants have located themselves close to sources of cheap power. The plants covered in Table II obtain power at an average cost of less than 2 mills per kilowatt hour from nearby hydroelectric power stations. Atomic power plants may be able to match these low costs at some time in the future, but it is questionable that they will lower electricity costs even further. It may be concluded from this fact, that costs in the aluminum industry, as presently constituted, probably would not be seriously affected by the advent of atomic power.

TABLE II

Costs of power and transportation of Bauxite and Alumina in the estimated average postwar cost of pig aluminum in Alcoa plants.

	Cents per Pound of Pig Aluminum	Percent of Total Cost
Power for Electrolytic Reduction of Aluminum (9 kilowatt hours per lb. of metal)	1.73	19.6
Transportation of Bauxite and Alumina	1.24	14.0
a. Bauxite from Dutch Guiana to Mobile, Alabama	0.55	6.2
b. Alumina from Mobile to electrolytic aluminum plants	0.69	7.8
Other Costs	5.87	66.4
Total Cost	8.84	100.0

Source: Adapted from data in "Aluminum Plants and Facilities," Report of the Surplus Property Board to the Congress, September 21, 1945.

However, another extremely important element in aluminum costs is the transportation of bauxite and alumina. The Alcoa plants covered in Table II derive their aluminum from bauxite mined in Dutch Guiana. The bauxite is shipped to an ocean port in the United States (in this case Mobile) for the first stage in the reduction process—the conversion of bauxite to alumina. If the bauxite is shipped dry, approximately 1.7 tons are required per ton of alumina.

The alumina produced in Mobile is then shipped to plants close to cheap power for the last stage in the production of the metal, the electrolytic reduction from alumina to aluminum. Two tons of alumina must travel to these plants for each ton of aluminum produced. In total, therefore, the cost of transporting 3.4 tons of bauxite from Dutch Guiana to the United States, and 2 tons of alumina from Mobile to aluminum plants in various parts of the country is included in the cost of producing a ton of aluminum.

The transportation of aluminum raw materials which enters into the cost of producing aluminum results from the need to bring raw materials to cheap power. Under present circumstances, it would be even more costly to bring power to raw materials since roughly 10 lbs. of coal would be required to produce sufficient power for the reduction of 1 lb. of aluminum, while only 3.4 lbs. of bauxite need be shipped to power. The relationship between the weight of raw materials and the weight of fuels required per ton of aluminum could, however, be completely reversed by atomic fuels, one pound of which yields enough energy to produce 250,000 lbs. of aluminum. Thus, one pound of atomic fuel could be shipped to bauxite instead of shipping close to 1 million pounds of bauxite to power.

The size of the cost reductions which might result from bringing power closer to aluminum raw materials, may be judged from Table II. For example, if aluminum reduction works could be based on cheap power at Mobile, a saving of close to 8 per cent in production costs would be effected, all other factors being equal; and if an integrated aluminum works could be based on cheap power in Dutch Guiana, a saving of 14 percent in costs could result.

Clearly such a calculation does not provide a basis for undertaking the development of aluminum production at new locations: the availability of other raw materials, the adequacy of the labor supply, and the cost of transportation to possible markets are among the other economic factors which would have to be considered. It does, however, illustrate the type of economic factors which may come into play in determining the aluminum industry's structure if cheap power can be made available, wherever needed. Perhaps atomic power will reduce power costs at Mobile, Dutch Guiana, or other places suffi-

(Continued on Page 125)

Atomic Energy in the News . . . .

IN THE U. S. SENATE

IN the last issue we reported in considerable length the proceedings in the Senate Committee on Atomic Energy, devoted to the confirmation of Mr. Lilienthal and his four co-appointees as members of the U. S. Atomic Energy Commission, and of Mr. Wilson as General Manager. The hearings were concluded on March 10. Only Senator Bricker (R., Ohio) voted against Mr. Lilienthal's confirmation, while Senator Johnson (D., Colo.) joined him in opposition to Mr. Pike and Mr. Wilson.

In explaining his vote, Senator Bricker said that information on political reliability of some of the top new employees of the Atomic Energy Commission was only made available a few days before the vote, and that it contained certain data which he considered alarming. In developing this line of opposition, Senator Bricker introduced a motion on the floor of the Senate suggesting that the nominations be returned to the Atomic Energy Committee for further investigation, and that the F.B.I. be asked to supply data on *all* employees added after the Commission took over — 700 and more, ranging from janitors to top scientific men. President Truman was quoted as opposing this request and stating that opening of F.B.I. files to members of a Congressional Committee is not desirable and has not been the practice in the past.

Senator Bricker's motion was defeated on April 3 by a vote of 52 to 38, with Senator Vandenberg leading the majority and Senator Taft voting with the opposition.

In addition to the proposal of Senator Bricker for returning the report to the Committee, another "wrecking" motion was introduced in both Senate and House by "bipartisan" groups — that of bypassing the Atomic Energy Commission altogether and transferring the authority over the atomic energy project to a group of Cabinet members headed by the Secretary of State. The justification was that the present political situation differs radically from that on which the adoption of the McMahon bill was predicated.

The Senate debate on the confirmation opened on March 24, with a speech by Senator Hickenlooper (R., Iowa), the Chairman of the Committee, who stated that "The confusion and chaos that would be necessitated by a repudiation of the Presidential appointments at this time and the mad scramble for satisfactory replacements for this Commission would be almost fatal to our program."

Senator Hickenlooper defended Mr. Lilienthal as an outstanding administrator and public servant and said his group had found no evidence he was a Communist or Communist-sympathizer, as was charged by his opponents.

The debate continued spasmodically, with long interruption for other sometimes important and sometimes trifling business until April 9 when Lilienthal was confirmed by a vote of 50 to 31, and his colleagues by a voice vote. *There is little doubt that the delay in the development of the American project, caused by the wrecking tactics of a Congressional minority, has been as valuable—if not more valuable—to the nations which are anxious to catch up with us, as would be the acceleration of their own effort by information from spies which they might succeed in planting in our factories or laboratories.*

In the United Nations

The Security Council's unanimous decision to return the atomic energy problem to the Atomic Energy Commission was made on March 10 and the history of this decision — including the violent attack on the American plan by Mr. Gromyko on March 5 — was reported in the last issue of the BULLETIN. Because of this attack, a reference to a "considerable area of agreement" was eliminated from the resolution of transmittal. Instead, one paragraph of the resolution stated that "an agreement by any nation to the separate portions of the report is preliminary since final acceptance . . . is conditioned upon its acceptance of all parts of the control plan in its final form." The Soviet delegate sought to eliminate this sentence, intended to stress the connection between the outlawing of atomic weapons, and a general control scheme, but his amendment was defeated.

The hope that the Atomic Energy Commission may succeed where the Security Council failed, was based on the agreement reached in the past by the scientific and technical sub-committees working behind closed doors and concerned with practical and technological aspects of international control, rather than with such "hot" political questions as that of the "veto." The first move, after the Atomic Energy Commission met again on March 19, was therefore to ensure that further considerations be carried out behind closed doors.

Mr. Gromyko said that the discussion of the Commission's work could better be carried out in the committees than in the plenary sessions. He later emphasized that he wanted the Soviet amendments and proposals to be considered "first of all."

The United States Representative said that "it is highly probable that the most speedy progress could be made if we were to take one of the most difficult questions first, and dispose of it, such as the establishment, composition, organization, powers and status of the international agency for control of atomic energy."

Mr. Parodi (France), in supporting the resolution, said that "progress stopped" when the control questions were thrown over to public debate, in the Security Council.

In the U. S. Atomic Energy Commission

On March 19, the Commission issued regulations for the sale and use of uranium and thorium. After April 1, uranium cannot be used any more in ceramics, glass and photographic films "except under exceptional circumstances."

Uranium and thorium ores containing more than 0.05% of these metals, were defined as source materials to be controlled in the sense of the McMahon bill. They can be exported only under special licenses. Amounts containing over ten pounds of uranium or thorium must be reported to the Commission.

The Organization for Science[1] in the Federal Government . . . . . by Philip N. Powers[2]

♦ A Report on the Existing Government Agencies for Coordinating Research

THE EXPANDING ROLE of science in the Federal Government has already brought about the establishment of several new scientific organizations, and more are proposed in various bills[3] now before Congress, the most imoprtant of which is a National Science Foundation. Except to mention the Thomas Bill (S.525) and the Smith Bill (S.526) as the two most prominent proposals, this article is primarily intended to provide a brief description of the over-all structure within government where scientific activities are centralized.

The chart shows each of the departments and independent establishments having a major interest in scientific endeavor. Except for the Research and Development Division of the War Department General Staff and the Office of Naval Research, which are of special interest, the structure at lower levels is not shown. The chart is, therefore, only a skeleton of the organization for science in the Federal government. The Bureau of Standards within the Department of Commerce, the Agricultural Research Administration within the Department of Agriculture, the U. S. Public Health Service within the Federal Security Agency, and many others[4] are omitted. The National Academy of Science and the National Research Council are omitted because of their quasi-official character.

The President's Scientific Research Board

This Board was established by Executive Order in October 1946 under the chairmanship of Dr. John R. Steelman. Assisted and advised by the Board, the chairman is given a broad assignment which in effect directs him to prepare a report on the status of American science and to make recommendations concerning Federal research programs. The Board is temporary and has no function other than to report to the President. It is not in any sense to be confused with the proposed National Science Foundation.

To coordinate the preparation of the report, a small full-time staff has been set up in the Executive Office of the President by the Chairman of the Board. Dr. J. Donald Kingsley is serving as Executive Secretary. It is anticipated that the report will be complete by July 1, 1947.

The members of the Board are the Secretaries of Agriculture, Commerce, Interior, War, and Navy, the Chairman of the Atomic Energy Commission, the Federal Communications Commission, the National Advisory Committee for Aeronautics, and the Tennessee Valley Authority, the Administrators of Federal Loan, Federal Works, Federal Security, and Veterans Affairs, and the Director of the Office of Scientific Research and Development.

The Joint Research and Development Board

The Joint Board was set up by the Secretaries of War and Navy in June 1946 and serves as a sort of umpire in coordinating all research and development activities of interest to both Departments. More important, it is intended to promote the establishment within the Departments of a complete — and strongly unified and integrated — research and development program in the field of national defense. Having authority to speak for the two Secretaries, it guides the Departments in resolving administrative and technical conflicts and determining final allocation of projects. Decisions are also made on the emphasis which should be placed on each of the various research and development programs.

The Chairman of the Board, Dr. Vannevar Bush, reports directly to the two secretaries. The two Army representatives are Generals Carl Spaatz and J. L. Devers, Commanding Generals of the Air Forces and Ground Forces, respectively. Admiral D. C. Ramsey, the Vice Chief of Naval Operations, and Mr. W. John Kenney, Assistant Secretary of the Navy, are the Navy members. L. V. Berkner serves as Executive Secretary.

The Board operates through a full-time Secretariat, which gathers scientific information and plans programs, and a series of committees made up of representatives of the two departments and of eminent civilian scientists. Committees on Atomic Energy, Aeronautics, Guided Missiles, Electronics, Geographical Sciences, and Geographical Exploration are now functioning.

The Office of Naval Research

The Office of Research and Inventions, established by the Secretary of the Navy in May 1945, became, by Act of Congress, the Office of Naval Research in August 1946.

The Chief of Naval Research is responsible for initiating, planning, promoting and coordinating the naval research program. He is to insure a steady flow and inter-exchange of scientific information among the various activities performing research and development work within the Navy.

He is the principal adviser to the Secretary of the Navy on Research. He makes research contracts with outside organizations, and determines Navy policy on patents, inventions, trade marks, copyrights, royalty payments and classification of research projects. In addition to servicing contracts and administering public and technical information programs, the staff of ONR has responsibility for the development of a program to ensure to the Navy adequate civilian scientific manpower resources. In addition to its "Planning" and "Patents and Inventions" Divisions, and its field office, the ONR also has three laboratories: the Naval Research Laboratory, the Special Devices Center, and the

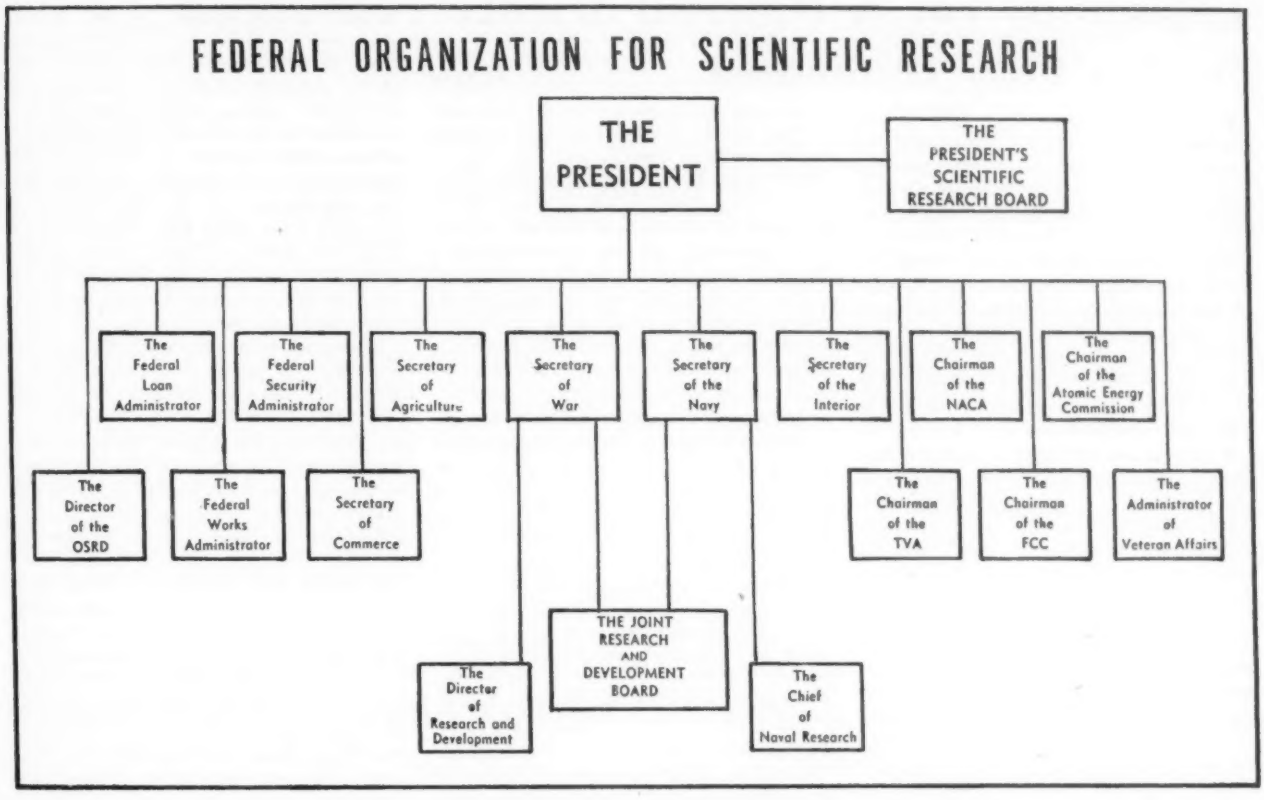
PHILIP N. POWERS is a member of the President's Scientific Research Board Staff, Washington, D. C.

1 As used in this article, the term "science" includes physical and biological science, and not social science.

2 The views expressed in this article are personal and not official, and the assistance of Mr. James Ficken in its preparation is gratefully acknowledged.

3 For example, H.R. 977 proposes a National Medical Research Foundation, as an independent agency and S. 176 a National Institute of Dental Research within the U. S. Public Health Service.

4 A complete chart of the scientific activities of the Federal government would show some forty or more major research agencies, related by a variety of inter-agency coordinating groups and advised by a number of specialized non-government or partly non-government bodies.


FEDERAL ORGANIZATION FOR SCIENTIFIC RESEARCH
THE PRESIDENT
THE PRESIDENT'S SCIENTIFIC RESEARCH BOARD
The Federal Loan Administrator
The Federal Security Administrator
The Secretary of Agriculture
The Secretary of War
The Secretary of the Navy
The Secretary of the Interior
The Chairman of the NACA
The Chairman of the Atomic Energy Commission
The Director of the OSRD
The Federal Works Administrator
The Secretary of Commerce
The Chairman of the TVA
The Chairman of the FCC
The Administrator of Veteran Affairs
THE JOINT RESEARCH AND DEVELOPMENT BOARD
The Director of Research and Development
The Chief of Naval Research

Underwater Sound Reference Laboratory.

The contracting and coordinating responsibilities for fundamental research are centralized in the planning Division which in turn has three technical branches:

1 *The science branch* analyzes research and prepares surveys and recommendations in the fields of physics, nuclear physics, electronics, chemistry, fluid mechanics, mechanics, materials and mathmatics.

2 *The program branch* is responsible for making applications of science to specific fields of Naval activity. Programs organized to date relate to: air, armament power, geophysics, surface and subsurface warfare, and amphibious warfare.

3 *The medical sciences branch* studies the application of medical research to the problems encountered by Naval Personnel in the course of their service. This branch is divided into sections on bacteriology, biochemistry, biophysics, psychophysiology, environmental physiology, physiology and psychology.

The Research and Development Division of the War Department General Staff

The Director of Research and Development is a member of the General Staff, G-6. Although his position is comparable to that of the Chief of Naval Research there are basic differences. G-6 is not an operating agency, and does not itself contract for research, but it is primarily concerned with the coordination and stimulation of research and development. The Director is also the chief adviser to the Secretary of War on research and development, but his office has not been established by Act of Congress as has ONR.

Responsibility for the "mobilization and application of national research and development resources in support of the mission of the Army" is in G-6. The Director is also charged with the promotion of "pure and applied scientific research of potential military value." He formulates and supervises all research and development undertaken by the War Department or by private establishments under War Department contracts, and he provides a clearing house for the dissemination of results of research to the various operating and technical services of the War Department.

The major fields of research and development with which the Army is concerned are atomic energy and fission products, chemical warfare, engineering, military medicine, general ordnance, ammunition, artillery, free rockets and launchers, small arms, tanks and motor transportation, quartermaster corps studies, signal corps studies, communications, meteorology, radar, transportation, and the environmental factors affecting military operations and personnel.

The Army Air Force is primarily concerned with programs in the field of aerophotography, aeromedical research, aircraft armament, aircraft equipment, aircraft materials, aircraft power plants, aircraft structures, climatic projects, electronics, guided missiles, personal equipment, and propellors and rotors.

G-6 is also responsible for planning for the mobilization of scientific manpower in

(Continued on Page 126)

Legislation For A National Science Foundation . . .

The Bills Under Consideration . . . by J. E. Mayer

THERE are two major bills on the Senate floor, S-525 introduced by Thomas of Utah and S-526 introduced by Smith of New Jersey for himself, Cordon, Revercomb, Saltonstall, and Magnuson, both bills for the purpose of creating a National Science Foundation. There are five House bills on the same subject, four of which, HR1815, HR1830, HR1834 and HR2027 are identical to S-562, and one, HR942, is the same as S-525. The Smith Bill has now been reported favorably back to the Senate by the Committee on Labor and Public Welfare.

The Senate Bill S-525 is the same as the "Kilgore Bill" passed by the Senate in the last session whereas the Smith Bill, S-526, is a new one. In many respects, and indeed, probably in most respects which concern the actual functioning of the Foundation as an organization for the support of science, the two bills are similar or identical. However, the form of administrative organization is quite different in the two bills, and in addition they differ in (2) questions of patent policy, in (3) the question of inclusion of the social sciences, and in (4) the details of distribution of research funds.

The bills agree in establishing a Foundation, which shall be administered by a full time administrator and his deputy, either responsible to, or advised by, a small board of part-time scientists (9 to 12 members) meeting some six times yearly or more. The Foundation shall have a number of divisions, including one of national defense, and shall support research by contracts with outside organizations, such as state or private universities or hospitals, etc. In addition it shall, by fellowships and scholarships, aid students in the sciences. The Foundation will not have laboratories of its own, but would cooperate with other government institutions doing research.

The Thomas Bill, S-525, has the director and board responsible to the President and Congress. The Smith Bill, S-526, sets up a foundation of 24 members, presumably mostly scientists, appointed by the President with advice and consent of the Senate, to whom the smaller executive board and the director are responsible. Thus control, in this bill, is taken rather far out of the hands of the President and Congress.

The Smith Bill requires patent policy "calculated to protect the public interest" whereas the Thomas bill has fairly stringent requirements making it difficult or impossible for the institutions in which research is supported to patent discoveries made by research supported through the Foundation.

The Thomas Bill states the divisions which shall be formed, and does not include the social sciences, whereas the Smith Bill, only suggesting the arrangement of divisions (but requiring national defense and medicine) permits, by inference, a division of the social sciences to be formed.

The Thomas Bill requires 10% of the money spent on research to be divided equally among the states, and 15% to be divided according to population. The Smith Bill has no such provision.

Although it would be an error for scientists to support a bad bill, containing a stupid administrative setup, merely because it promises to support science, it is still clear that the details of the administrative method is not a question about which scientists, merely by virtue of being scientists, are more competent to decide upon than any other citizens. Similarly the very sensible suggestion has been made, and appears to be gaining in favor, that an entirely separate bill defining patent policy for *all* government contracts, should be drawn, rather than that it should be written into the bill on this Foundation. With regard to the geographic distribution of funds one may note that the requirement of the Thomas Bill is that only 0.2% of the total research funds go to one state, by virtue of its being a state, and only 25% in all must be distributed by any rules. This is scarcely a confining requirement.

There is a tendency on the part of some scientists to oppose the inclusion of a division of national defense. Presumably army-navy research on specific weapons will continue. The tone of the bill implies that defense research will be interpreted as basis research in fields of interest to defense, such as trans-sonic aerodynamics and shortwave electromagnetic phenomena. In time of emergency the existence of this division will permit the Foundation to support defense contracts when and if the scientists of the country show a great desire to enter such contracts.

Comment from Oak Ridge . . . by L. W. Nordheim

THE following ideas on the National Science Foundation were discussed by a number of members of the Executive Committee of the Association of Oak Ridge Engineers and Scientists. The formulation and details are entirely the responsibility of the writer.

In the words of Vannevar Bush, our wartime effort has dried up the national reserves in scientific manpower and in new ideas. We feel that a primary function of the National Science Foundation should be to replenish these resources, to further education and to stimulate basic research which always precedes the more practical developments.

There is much confusion in the public mind as to the nature of science. Spectacular success in applications are taken as fundamental advances. Particularly, it is forgotten that the most successful contributions to the war effort, such as the atomic bomb and radar, were based on previously discovered principles and were carried out by well grounded scientists, not by narrow specialists. It seems to us that the presently proposed science bills are still suffering from lack of clarity in this distinction. We feel that sight should not be lost of the broader issues in the effort to get "a bill" through Congress, and we do not believe that our chances are lessened materially by a straight-forward and sincere discussion.

We believe that true scientific education and research can flourish only if they are conducted in the way hundreds of years of academic tradition have taught us, that is, free from profit motives and free from any restrictive security regulations.

These remarks do not mean, of course, that activities in developmental and military research should be curtailed. Support for these will always be more easily obtained since their objectives are so much more tangible. However, unless the distinction between the two types of activities is made perfectly clear, there is a great danger that restrictions from the applied field will encroach over all activities of the administering agency.

We are not so much concerned about the administrative set-up of the National Science Foundation. We feel, however, that it should be clearly expressed in the bill that basic research under it should be in the public interest and that it should be free from security regulations, and also from narrow restrictions as to subject; and that the same freedom should prevail for the distribution of scholarships and fellowships.

It is obviously desirable that the administration of such activities should be as far as possible removed from political and military influences. If it is set up in the framework of a wider bill, a definite separate board or committee would have to be provided. The sum required by it would comprise only a small fraction of the total spent by the government on research purposes, but it would constitute an invaluable insurance for the continued flourishing of science in our country.

Calling for a Crusade

(Continued from Page 106)

goods if we were willing to make this possible by our tariff policy. But we are not willing to do this either.

The point I am trying to make is this: that nothing much can be achieved now or in the very near future until such time as the people of this country understand what is at stake. As far as the bomb is concerned, the people have not been told the whole story, nor have they fully understood what they have been told. What we need in this country now is a crusade —a crusade for an organized world community. There will be elections in '48 and again in '52. The issue before us will not be a partisan issue. Atomic bombs are not precision instruments, they cannot discriminate between Republicans and Democrats. Most elections are pretty close and a rather small fraction of the voters who are willing to disregard all other issues and to cast their vote solely on the issue of establishing peace by creating a world community, could decisively influence the nominations and elections in many of the states.

Today, if the Government were to approach Russia, she would hardly be willing to go along and do all that needs to be done. But suppose that a crusade should really get under way here in America. Clearly, there will be a fight—possibly a very big fight. Other nations will sit up manence. Because there will be a fight, should be won and a President who has seen the light should approach the other nations with the backing of the people and Congress, then I believe we would have a very different situation, and Russia might go along.

Because there will be a fight, we can win something that has roots and permanence. Because there will be a fight the American people will look and listen. And when the people of this country at last understand their own position in the world, they might be willing to do what is necessary.

Obviously the odds are heavily against us but we may have one chance in ten of reaching safely the haven of permanent peace; and maybe God will work a miracle —if we don't make it too difficult for Him.

Economic Aspects of Atomic Energy As A Source of Power

(Continued from Page 120)

ciently to encourage the development of new productive activities. This would result not only in a quickening of economic activity in the regions affected, but also in reductions in the cost of aluminum production which might prove important in awakening new demands for aluminum and its products throughout the world.

In discussing the economic effects of atomic energy, the following points have emerged: Measured purely in terms of the savings involved in substituting atomic fuels for other fuels in the generation of electricity, the economic importance of atomic energy does not appear to be great. However, this calculation neglects the facts that historically the cheapening of power has been of major importance in economic growth, a factor which transcends in importance the savings involved in the substitution of one fuel for another. In this connection, it was noted that the unique mobility of atomic fuel renders it ideal for the purpose of providing cheap power in regions remote from other energy recources.

Finally, it was stressed that even in regions with abundant fuel resources, atomic energy might have important implications for the major energy consuming industries. Such industries could experience reductions in production costs either through the cheapening of power, or, as may be possible with aluminum, through the development of production at new locations in which atomic fuel is brought to raw materials which had previously to be shipped to other sites for processing. It was suggested that this could have a double-edged importance, resulting both in economic expansion in the regions affected and in the growth of demand for those products whose costs had been reduced.

III—Concluding Remarks

To this point in the discussion we have considered two main topics: the cost of producing atomic power, and the economic effects of the use of atomic power. Both were discussed on the assumption that economic factors would be allowed full sway in determining the manner in which this new force will be exploited. However, the enormous military importance of atomic explosives renders the exploitation of atomic energy inescapably subject to non-economic consideration. This is true whether there is international control or not. In either case political considerations will take precedence over purely economic goals.

If the nations of the world do not agree on the international control of atomic energy, it is likely that an atomic arms race will occur. Under such circumstances it is probable that atomic power will result, if at all, only as a by-product of the production of atomic explosives. The cost of power will, in this case, be arbitrarily determined and will depend on the size of the military subsidy. The choice of areas in which atomic power will be made available will be determined by security considerations, and might be completely unrelated to the relative urgency of the need for power.

Factors Restricting Development

International control of atomic energy could also have serious economic implications. It is possible that the control plan which governs the development of the world atomic energy industry may impose restrictions with respect to the design of atomic piles as a security measure.[9] The existence of this type of institutional rigidity could result in higher costs of atomic power than if there were complete freedom of choice with respect to plant design.

Furthermore, security considerations might dictate a severe limitation on the size of the world atomic energy industry —and its distribution—in order to minimize the dangers from diversion of materials or seizure of plant.[10] This factor could operate to vitiate, in part, the important possibilities of atomic power in expanding economic life in regions remote from other energy resources, and in encouraging new industrial locations through the availability of cheap power, wherever needed. Whether, and how severely, political forces will limit the economic benefits of atomic energy, time alone will tell.

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9 For example, The Acheson-Lilienthal plan for the international control of atomic energy provides that certain plants (producing approximately one-half of the total world output of atomic power) shall be designed in such a way that they will not be able to produce new fissionable substances.

10 This consideration has been stressed in certain materials submitted by Mr. Baruch to the United Nations Atomic Energy Commission. See, for example, *Technological Control of Atomic Energy Activities*, Scientific Information Transmitted to the United Nations Atomic Energy Commission by the United States Representative, Vol. VI, October 14, 1946.

The President Addresses the World

(Continued from Page 110)

being misled by their governments, and this should be done in spite of any protest against such action by the recalcitrant governments. But in the last resort we must be prepared to use force. Once the situation is clearly seen there is no way of avoiding the steps I have indicated.

Even if recalcitrants should press us to this extremity, this does not mean an immediate all-out attack with atomic bombs. The nature of the force to be used against a recalcitrant country becomes a matter of strategy and tactics, directed toward getting the country to join the World Peace Plan on the same conditions as the other countries and the United States, while keeping to a minimum the destruction and suffering and the consequent bitterness. But humanity must not be allowed to become an excuse for cowardice. It must not be allowed to force us to accept the only alternative policy which is to wait until the recalcitrants have accumulated enough atomic bombs to destroy the whole world.

I have described the terrible nature of our situation and have indicated a way to safety. I am confident that once the first step is taken the others will follow smoothly and quickly and that even though we must be prepared for all eventualities, there would be no need to use force against recalcitrants. But the most difficult step is the first step—to get the American people and their representatives to agree quickly on the adoption of the Peace Plan and to forget their small differences, for all our differences are small in comparison with the question of war or peace.

Decentralization

If we should fail to do this the atomic war will come in a few years, and we must grimly devote ourselves to the task of trying to save what can be saved out of the world destruction. For this it will be necessary to decentralize our whole economy, relocating our cities in ribbons spread evenly over the whole country, putting vital defense elements deep underground, mobilizing everything with an intensity that has not been equalled anywhere on the earth and involving a detailed central control over the occupation, location, and habits of every man, woman and child in the country, squandering on this at least as much as we would have invested in the World Peace Loan. The fundamental freedoms will have gone by the board. Our only consideration will be that enough of us survive the disaster—if indeed the atomic poisoning of the atmosphere shall not render our planet completely uninhabitable—to begin life again when we emerge from a darker dark age.

Four Commissions

To carry out the proposals I hereby appoint four commissions. The first commission will draw up details of a plan for the constitutions of the International Police Force and the World Court (which some may wish to call the World Government) which will take the place of war in settling disputes between nations.

The primary objectives of the constitution will be (1) to see that the machinery for settling disputes is fair and unprejudiced and (2) to prevent the International Police Force from interfering in the domestic matters of any country, other than the inspection to prevent armament and the establishment and maintenance of the three fundamental freedoms. The Commission will submit the constitution to the UN for approval or amendment while inviting the Russians to propose alternative plans. This commission will also prepare the alternative peace plan that would be made necessary by the failure of UN to form itself into the International Police Force.

The second commission will work out plans for the World Peace Loan. It will have to find out as far as possible how much each country or region would like to borrow, what would be the nature of the excess imports it would obtain in the years it was borrowing to build up its capital equipment, and what would be the nature of its exports in the fifty years or so of interest payment and capital repayment. It will also have to check whether the plans of the various countries are consistent, both internally and with each other.

The third commission will study the available productive resources both of the U.S. and of the rest of the world to obtain the necessary background information which the second commission will need for preparing the World Peace Loan. This study of resources will also be helpful for other plans for development and effective utilization of resources both in the U.S. and in the rest of the world.

The fourth commission will study decentralization in the U.S., what it would cost both in material terms and in terms of interferences with the freedom of the individual, and will prepare a plan for decentralization to be ready to be put into action one year from today, the commission to give interim reports monthly.

We Must Act Now

If we in this country start the Peace Plan there is every reason to believe we will have peace and we will not have to forget our civilization and burrow underground to save some of us alive. I, therefore, hope and pray that the American people will through their representatives support and implement this policy so that it can be carried out during our period of grace. By so doing we will transform the atom bomb from an instrument of annihilation into the harbinger of peace.

The Organization for Science in the Federal Government

(Continued from Page 123)

time of war, the technical education of both military and civilian scientists in the War Department, and other scientific manpower problems.

The National Academy of Sciences and the National Research Council

The National Academy of Sciences was set up during President Lincoln's administration in 1863 by an Act of Congress in which the original members were specified by name. It is a self-perpetuating body which is made available to any department of the government which wishes an investigation, examination or series of experiments performed in any realm of science or art. Appropriations are made to cover the actual expense of preparing such reports, but the Academy itself receives no compensation for its services. At the request of President Wilson, the National Research Council was set up as an adjunct to the Academy to assist in carrying out its functions and to utilize more fully the professional societies for this purpose.

A Bibliography of Atomic Energy

(March 1, 1946 – February 1, 1947) . . . *Compiled by Morris C. Leikind*

[Commencing with this issue of the BULLETIN, it is the intention of the Editors to present a section informing its readers of articles and books of interest. In general, the information will be presented in the form of reviews and discussions of current books. In the beginning, however, it was believed advisable to present a bibliography surveying the literature now available. The Editors are grateful to the Library of Congress for permission to print this bibliography.]

[*This list of references supplements the bibliography of "Books and Articles on Scientific and Political Aspects of Atomic Energy" which was published in the "Report" of the Special Committee on Atomic Energy, U.S. Senate (see item 259). Attention is called here to the list of the first 270 atomic energy papers to be declassified by the Atomic Energy Commission or by its predecessor, the Manhattan Engineer District. Copies of this list may be obtained from the Office of Technical Services U. S. Department of Commerce. As additional reports are declassified they will be abstracted and listed in the "Bibliography of Scientific and Industrial Reports" issued by the Office of Technical Services*]

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MORRIS C. LEIKIND is Consultant in Science on the staff of the Library of Congress, Washington, D.C.

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The International Control of Safe Atomic Energy

(Continued from Page 116)

success as the T.V.A. has had as a social experiment is due to the pace and methods used in showing the people of the Valley how to work together. Education in living together is as important a component in the T.V.A.'s program and aim as is education in the methods of scientific farming.

Today the majority of the people of the world are helpless, uninformed, and concerned mainly with finding enough food. In these resepcts they are like babies. One does not give explosives to babies, and one does not invoke the baby's right to full and unfettered satisfaction of all its curiosities. As the people of the world become free, through education and adequate feeding, they will be able to make sensible judgments about the use they wish to make of nuclear fuels.

Our generation may well devote a major part of its energy to the job of catching up politically. It needs a peace during which to learn the sharp limitations of national advantage. It needs to find and learn a set of social values more suited to the technological era than the feudal and megalopolitan values received from the predatory past. It needs to develop the United Nations into a really democratic world government. It needs to go slowly in the develoment of atomic industry in order to minimize the threat of war in our time. If our generation establishes peace, any future generation can develop nuclear power; if our generation fails to establish peace, no one for many generations can develop nuclear power or anything else. International control of safe atomic science, and prohibition of dangerous atomic industry during our time, can be a real step toward world peace and permanent civilization.

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BULLETIN of the
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Chicago 37, Ill.

Editorial

(Continued from Page 101)

economic pressure, or concentrated propaganda, intended to gain support of the people of the U.S.S.R. for a radical change in policy which would make the U.S.S.R. a more willing partner in the world settlement. But, even if we do not intend it, the probability that such an all-out policy of coercion on our part, will lead to an armed conflict, obviously will be very great. A war, accelerated by our own forceful policy within the next few years, may leave the American homeland relatively untouched, but will mean a colossal new sacrifice of American blood, resources, and money, and will lead to a devastation, by American bombs, of most of Europe and a large part of Asia, leveling what was left standing there after the last war. Since America represents less than one-third of the Western world (of which Russia, despite its present separate ways, is an integral part), a devastation of the other two-thirds may well prove a death blow to all of it.

We have no doubt that a vast majority of the American people shudders at the idea that the only path to American security should be through the destruction of the rest of the Western world. This is why, whatever our best short-term strategy or tactics in dealing with the U.S.S.R. may be, the finding of a way to the elimination of atomic weapons by agreement must remain the central task of our policy. That is why we cannot rest in the satisfaction of having offered a fair and imaginative plan, and the disappointment of having seen it derided and largely rejected by the Soviet Union. We do not believe that all possibilities of peaceful solution have been exhausted.

New Plans

In the present issue, we print three articles which point out new possible paths. Messrs. Daniel and Squires suggest that universal renunciation of industrial atomic power may make international control less difficult. (A proposal for a five-year moratorium on atomic power was contained in the Chicago draft Convention, printed in Vol 1, No. 8 of the BULLETIN.) Mr. Szilard thinks that the international control of atomic energy may become acceptable to the U.S.S.R. if it is preesnted within the framewotrk of a much more comprehensive scheme of worldwide economic and cultural cooperation. Finally, Mr. Lerner refuses to despair in the ultimate success even if the mechanism of the UN should break down because of stubborn Soviet opposition, and calls for bold American leadership in such a critical situation.

E.R.

TO OUR READERS

With its next issue, the BULLETIN will adopt a new, expanded format designed for easier reading and more attractive appearance. The June issue will also bring another innovation — a cover designed to protect your copy in the mail and to preserve your BULLETIN for permanent filing.

In order to accomplish the change-over and to adjust our production schedule to the new format, the April and May issues have been combined in this volume. So that subscribers will receive 12 issues of the BULLETIN, all subscriptions now in effect will be extended one month to compensate for the change in dating.

The opinions expressed in the editorials and other articles printed in the BULLETIN do not necessarily represent the official views of any organization.

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EDITORS:
H. H. Goldsmith E. Rabinowitch
Assistant Editor: Alice Smith
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